FINAL
REMEDIAL INVESTIGATION REPORT
CHEROKEE COUNTY OPERABLE UNIT 8 RAILROADS SITE
CHEROKEE COUNTY, KANSAS

Prepared for:

U.S. Environmental Protection Agency Region 7
11201 Renner Boulevard
Lenexa, KS 66219

Architect and Engineering Services Contract EP-S7-05-05
Task Order: 0061

March 2016

HydroGeoLogic, Inc

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LIST OF ACRONYMS AND ABBREVIATIONS

ALM	adult lead methodology
ASR	analytical services request
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BLL	blood lead level
BNSF	Burlington Northern Santa Fe
CCR	Cherokee County Site-Operable Unit 8 Railroads
CDC	Centers for Disease Control and Prevention
CEC	cation exchange capacity
CLP	Contract Laboratory Program
CoC	chain of custody
COPC	contaminant of potential concern
CSM	conceptual site model
CTE	central tendency exposure
DQE	data quality evaluation
DQO	data quality objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
FS	Feasibility Study
HGL	HydroGeoLogic, Inc.
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
ICP	inductively coupled plasma
ID	identification
IDW	investigation-derived waste
IEUBK	Integrated Exposure Uptake Biokinetic
K_{oc}	carbon/water partition coefficient
LCS	laboratory control sample
µg/dL	micrograms per deciliter
mg/kg	milligrams per kilogram
MS	matrix spike
MSD	matrix spike duplicate

OSRTI	Office of Superfund Remediation and Technology Innovation
OU	operable unit
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity
ppb	parts per billion
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
r^2	correlation coefficient
redox	reduction-oxidation
RI	Remedial Investigation
RL	reporting limit
RME	reasonable maximum exposure
ROD	Record of Decision
RPD	relative percent difference
RSL	regional screening level
SAP	Sampling and Analysis Plan
SOW	Statement of Work
XRF	x-ray fluorescence

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1.0 INTRODUCTION

This Remedial Investigation (RI) Report describes the site characterization and results of the RI fieldwork completed for the Cherokee County Site - Operable Unit (OU)8 Railroads (CCR) site in Cherokee County, Kansas. These activities were conducted by HydroGeoLogic, Inc. (HGL) to support RI/Feasibility Study (FS) activities being completed under Region 7 U.S. Environmental Protection Agency (EPA) Architect and Engineering Services contract EP-S7-05-05, Task Order 0061.

1.1 SCOPE OF WORK

The RI component of the overall RI/FS was designed to collect data to characterize site conditions to a sufficient level of certainty and to support the evaluation of remedial alternatives in the FS. This RI Report presents and evaluates information and data from past investigations, details the field efforts completed in support of the RI, and presents and evaluates the analytical results and other data obtained during the RI field activities. EPA used the RI dataset to complete a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA). The HHRA and ERA evaluated whether current site conditions pose an unacceptable risk to human or ecological receptors. EPA's HHRA and ERA are incorporated into the RI Report.

Data collected during the RI will be used in the FS to evaluate viable remedial options, and select a remedy to eliminate, reduce, or control risks to human health and the environment. The FS report will be submitted under separate cover. The ultimate goal of the RI/FS is to support development of a Record of Decision (ROD) for the site.

1.2 OBJECTIVES AND REPORT ORGANIZATION

1.2.1 Objectives

The objective of the RI for the CCR site is to collect additional data necessary to support the FS leading to a ROD. To accomplish this objective HGL conducted the following activities:

- Identified and mapped active and historical rail lines and their condition using a pre-determined classification system;
- Determined the nature and extent of cadmium, lead, and zinc contamination in soil on and adjacent to the rail beds (of the former rail lines) at the site that exceed established Federal or State limits, or in the event such limits have not been promulgated, that pose human health or ecological risks above acceptable limits.

- Updated and refined the conceptual site model (CSM) to ensure site characterization is completed in sufficient detail to support decision making.
- Assessed actual and potential exposure pathways through affected media.
- Supplied the EPA risk assessors with the necessary data to prepare an HHRA and ERA.
- Prepared a comprehensive RI Report documenting the characterization work performed at the site to support the identification and evaluation of potential remedial options in the FS, with the ultimate goal of selecting an approach for site remediation in the ROD.

1.2.2 Report Organization

This RI report is organized as follows:

Section 1.0 - **Introduction:** Presents the purpose, scope, and objectives of the RI. The site background, site history, and previous investigations are summarized.

Section 2.0 - Physical Site Characteristics: Provides a regional and site-specific overview of the physical and environmental setting, including discussions of climate, topography, surface drainage, soils, geology, and hydrogeology.

Section 3.0 - **Study Area Remedial Investigation Activities:** Discusses activities conducted for the RI including property access, excavation of test pits for sampling, x-ray fluorescence (XRF) field screening of surface and subsurface soils, and the collection of correlation samples for laboratory analysis. In addition, sample data generated from the RI activities is presented.

Section 4.0 - **Quality Assurance /Quality Control Program:** Presents the quality assurance (QA)/quality control (QC) procedures implemented at the field and laboratory level to assure that data obtained were of sufficient quantity and quality to be used in decision making.

Section 5.0 - Nature and Extent of Contamination: Describes the extent of the cadmium, lead, and zinc contamination in the surface and subsurface soils identified along the rail beds.

Section 6.0 - Contaminant Fate and Transport: Details the physical form of cadmium, lead, and zinc and how they are expected to behave in the affected matrices. The chemical and biological transformations that affect contaminant migration are presented**.**

Section 7.0 - Baseline Risk Assessment Summary: This section summarizes the HHRA and ERA completed by EPA to support the RI. The HHRA and ERA were provided to HGL as standalone reports and, for completeness, are provided in this RI Report as Appendices J and K, respectively.

Section 8.0 - **Summary and Conclusions:** This section summarizes historical and current site data, the limitations of the data, and the conclusions that can be made from the total dataset.

Section 9.0 - **References:** Lists the references cited in the preparation of the RI Report.

1.3 SITE BACKGROUND AND SUMMARY OF PAST INVESTIGATIONS

1.3.1 Site Background

The Cherokee County Superfund Site spans 115 square miles and represents the Kansas portion of the Tri-State mining district (Figure 1.1). The Tri-State Mining District covers approximately 2,500 square miles in northeast Oklahoma, southwest Missouri and southeast Kansas and was one of the foremost lead-zinc mining areas of the world. The district provided nearly continuous production from about 1850 until 1970 during which it produced an estimated 500 million tons of ore, with about 115 million tons produced from the Kansas portion of the district.

The Tri-State Mining District is characterized by a variety of mine waste features that exhibit sparse to no vegetation. Local stream systems also contain mining wastes and mining-impacted sediments and surface water. Residential areas are adjacent to mine waste accumulations in some areas or have suffered historic impacts as a result of smelting. Lead and zinc are found in mining wastes and soils at maximum concentrations of several thousand milligrams per kilogram (mg/kg), while cadmium is typically found at levels less than 500 mg/kg.

EPA has listed four mining-related Superfund Sites in the Tri-State Mining District: the Tar Creek Site in Oklahoma; the Jasper County and Newton County sites in Missouri; and the Cherokee County Site in Kansas.

The Cherokee County Site consists of mine tailings, soil, sediment, surface water, and groundwater contaminated with heavy metals (principally lead, zinc, and cadmium). The primary sources of contamination are the residual metals in the abandoned mine workings, chat piles, and tailings impoundments in addition to historical impacts from smelting operations. The Site was placed on the National Priorities List in 1983. As listed, the Cherokee County Site encompasses 115 square miles including the following seven subsites: Galena, Baxter Springs, Treece, Badger, Lawton, Waco, and Crestline. These seven subsites encompass most of the area where mining occurred within the Site and where physical surface disturbances were evident. These subsites have been divided or grouped into the following OUs:

- OU1 - Galena Alternate Water Supply;
- OU2 - Spring River Basin;
- OU3 - Baxter Springs subsite;
- OU4 - Treece subsite;
- OU5 - Galena Groundwater/Surface Water;
- OU6 - Badger, Lawton, Waco, and Crestline subsites; and
- OU7 - Galena Residential Soils;
- OU8 – Railroads; and
- OU9 – Tar Creek Watershed.

OU8 comprises the portions of the rail lines within the Cherokee County Site that do not traverse other OUs. During the years the mines operated, railroads were constructed in Cherokee County to join conventional large-scale railroads to the individual mining operations. Figure 3.1 illustrates the current and former rail line locations through the County. The ballast material used in the railroad beds was composed of chat from surrounding mine waste piles. Traditionally, these historical railroads were abandoned in place when mining operations ceased at that mine. Currently, the historical rail lines that cross through private property vary in condition: some show little deterioration from their original condition; others have degraded to the point they are unidentifiable as former rail lines. Depending on the current use of the area, some former rail lines exhibit extensive vegetative regrowth with a thick organic layer, while others have been incorporated into the surrounding area. Some historical rail lines have been investigated and remediated within other OUs. At some locations, some of the ballast may have been completely removed in areas along the rail lines as a result of construction activities, such as highway cuts.

Recently, many rail lines were abandoned by railroad companies and reverted back to the property owner through the Surface Transportation Board. Regional plans exist to convert some historic rail beds to the national Rails to Trails program. This conversion program has begun in the Missouri part of the region with potential expansion into Kansas. This potential change in land use affects the exposure scenarios evaluated in the HHRA and ERA.

1.3.2 Previous Investigations

Numerous remedial and removal actions have taken place throughout the Site as noted in RODs and Five Year Reviews for the various OUs. Only those segments of the rail beds that run through other OUs or subsites at the Cherokee County Site have been investigated and remediated. This is the first investigation of rail lines that are not associated with investigations at areas identified as mining sites and characterized as part of another OU.

2.0 PHYSICAL SITE CHARACTERISTICS

This section presents descriptions of the regional climate and topography. Site-specific soils, geology, and hydrogeology also are discussed along with a brief summary of land and groundwater use in relation to the Site population.

2.1 REGIONAL CLIMATE

The climate is typical of the interior of large continents in the middle latitudes with large seasonal variations in both temperature and precipitation. The temperature and precipitation data that follows was provided by the Weather Data Library from the Department of Agronomy at Kansas State University in Manhattan, Kansas (KSU, 2012).

The following averages are based on 1981 to 2010 hourly data from a weather station based in Columbus, Kansas, which is just outside the Site area (Figure 1.1). The months listed below represent the high and low temperature and precipitation months. The mean temperature for January was 33.2 °F and, the mean temperature for July was 79.5 °F. The average daily minimum temperatures ranged from 23.4 °F in January to 69.4 °F in July. Precipitation ranged from 1.63 inches in January to 6.28 inches in May, with an annual average of 45.34 inches. Snowfall averaged 9.8 inches per year.

2.2 REGIONAL TOPOGRAPHY AND HYDROLOGY

The topography in southeast Kansas is generally gently sloping, except in the river valleys and areas of waste stockpiles and collapsed mine areas (Figure 1.1). Topographic relief in the stockpile areas within the Cherokee County Site approaches over 50 feet. Topographic relief associated with existing mine shafts and collapse features is on the order of 50 to 100 feet. Side slopes along the collapse features are generally very steep. The site topography along the rail road lines follows the regional topography.

The area generally east of the Spring River is in the Springfield Plateau section of the Ozark Plateaus province and is typical of the hilly timbered land in the Missouri Ozarks. Local relief between hilltops and stream valleys is as much as 200 feet in this area.

The county is drained by the Neosho and Spring rivers and their tributaries. Principal tributaries of the Neosho River in Cherokee County are Lightning, Cherry, and Fly Creeks. Principal tributaries of the Spring River are Cow Creek, Shawnee Creek, Shoal Creek, and Brush Creek.

2.3 SOILS

Appendix A provides a custom soil survey report with soil map for the site area from the Natural Resources Conservation Service. There are five major soil groups in the project area are that comprise approximately 80 percent of the soil cover in the site area:

- Hepler Group - Consists of deep, nearly level soils derived from alluvium of floodplain and floodplain step areas, primarily in the Spring River System. This association covers approximately 11 percent of the land and is considered prime farmland in areas where flooding is controlled. The soil texture ranges from a silty loam to a silty clay loam.

Permeability of these soils is moderately low to moderately high, and they are poorly drained. Surface runoff is generally slow.

- Dennis Group – Composed of silt loam derived from silty and clayey residuum weathered from shale. This group covers approximately 25 percent of the land and exists as interfluves separating drainage areas. It is considered prime farmland. It is a well-drained soil with low to high permeability.
- Taloka Group - Composed of silty loam to silty clayey loam derived from alluvium and colluvium over sandstone and shale residuum. This group covers approximately 17 percent of the land and exists as paleoterraces with 0 to 1 percent slopes. It is considered prime farmland. The Taloka Group is somewhat poorly drained with very low to moderately low permeability.
- Bates-Collinsville Group – Consists of loam to clayey loam derived from residuum weathered from sandstone and shale. This group covers approximately 9.5 percent of the land and exists as interfluves and hillslope soils on sandstone and shale residuum. It is considered prime farmland. The Bates-Collinsville Group is well drained with low to high permeability.
- Clarksville-Nixa-Tonti - Consists of gravelly silty loam derived from residuum weathered from limestone. This group covers approximately 18 percent of the land and exists as hillslopes and interfluves. It is not considered prime farmland. The Bates-Collinsville Group is moderately well drained to somewhat excessively drained with low to high permeability.

Each soil association shows natural variability and is named for the major soil types within the unit.

2.4 GEOLOGY AND HYDROGEOLOGY

Cherokee County occupies parts of two physiographic provinces defined by Fenneman (1946). Most of the county is in the Osage Plains section of the Central Lowland province, which comprises the typical rolling prairie of eastern Kansas. Large parts of the county that are underlain by easily erodible shale appear to be nearly flat. The southeastern corner of the county is in the Springfield Plateau section of the Ozark Plateaus Province, which is an upland area dissected by stream channels and karst features.

2.4.1 Geology

According to *Description of the Surficial Rocks in Cherokee County, Southeastern Kansas* (Seevers, 1975), rocks exposed at the land surface in Cherokee County are mostly limestone and shale of the Mississippian and Pennsylvanian Systems, and silt, clay, sand, and gravel of Quaternary age. The consolidated bedrock dip west/northwest at about 20 feet per mile, and progressively older rocks, therefore, are exposed from west to east. Most of the study area is underlain by the Krebs Formation; however, the formation is absent in the southeastern part of Baxter Springs, where the Mississippian System carbonate rocks can be found at the surface. Unconsolidated deposits of silt, clay, sand, and gravel of Quaternary age fill stream valleys incised into the older rocks. The following is a generalized stratigraphic column of the geologic units found in Cherokee County.

System/ Series	Geologic Unit	Description	Average Thickness (feet)
Quaternary/ Pleistocene	Alluvium	Silt, and silty sand, gray to grayish-brown, limonite stained in part; contains some sand and medium to coarse gravel at base.	30
	Terrace deposits		25
Pennsylvanian	Fort Scott Limestone	Limestone, light-gray to brownish-gray, and black to light-gray shale.	20
	Cabaniss Formation	Shale, light- to dark-gray; contains siltstone, limestone, sandstone, and coal.	225
	Krebs Formation	Shale, light- to dark-gray, and fine- to medium-grained sandstone; contains coal, underclay, siltstone, and some limestone locally.	225
Mississippian	Undifferentiated rocks of the Chesteran Series	Limestone, shaly, and calcareous shale; contains some oolitic limestone and sandy shale.	120
	Warsaw Limestone	Limestone, crinoidal; contains much gray chert. Base marked by glauconite-rich layer known locally as the "J-bed". Contains deposits of lead and zinc of commercial value.	180
	Burlington-Keokuk Limestone	Limestone, medium to coarsely crystalline, bluish-gray, and gray chert; contains oolitic limestone near top. Cherty parts weather to characteristic reddish-brown color. Contains deposits of lead and zinc of commercial value.	130
	Fern Glen Limestone	Limestone. Reeds Spring Limestone Member (upper unit) is cherty, finely crystalline, bluish- gray. Contains deposits of lead and zinc of commercial value. St. Joe Limestone Member (lower unit) is crinoidal, dolomitic in part, green.	170
	Northview Shale	Calcareous gray-green shale.	55
	Compton Limestone	Greenish-gray shaly limestone; general chert free.	25
Devonian	Chattanooga Shale	Fissile black shale; generally not present in study area.	10
Ordovician	Undifferentiated Cotter and Jefferson City Dolomites	Cherty dolomite and sandstones.	380
	Roubidoux Formation	Sandy dolomite with chert.	175
	Gasconade Dolomite	Light-gray coarse crystalline dolomite; lower part composed of sandy dolomite.	250
Cambrian	Eminence Dolomite	Medium to massive bedded light gray coarse-grained dolomite.	185
	Bonterre Dolomite	Medium to fine crystalline dark gray-brown dolomite.	185
	Reagan Sandstone	Medium to coarse-grained sandstone grading upwards to shale and dolomite.	135

2.4.2 Hydrogeology

The Site lies within the Ozark Plateau aquifer system (Imes and Emmett, 1994). Locally there are two aquifer systems, a shallow system and a deep system. The Warsaw Limestone, the Keokuk Limestone, and the Fern Glen Limestone comprise the shallow aquifer system known as the Springfield Plateau aquifer. This shallow aquifer lies at a depth of approximately 250 feet below ground surface (bgs) (Imes and Emmett, 1994). In addition, water from this shallow aquifer system is generally poor quality and the water is generally not used for domestic or stock supplies. Based on water level data from 1981, regional flow in the shallow aquifer system is to the west/northwest (Dames & Moore, 1993). The primary source of recharge to the shallow aquifer system is precipitation and infiltration in the area of exposed Mississippian formations that comprise the aquifer (Imes and Emmett, 1994).

The Northview Shale, Compton Limestone, and Chattanooga Shale underlying the shallow aquifer system do not yield water. They form an aquitard approximately 20 feet thick that separates the Springfield Plateau aquifer from the deep aquifer system known as the Ozark aquifer. The top of the deep Ozark aquifer lies at a depth of approximately 500 feet bgs (Imes and Emmett, 1994). The deep aquifer system is composed of Ordovician and Cambrian-aged dolomites: Undifferentiated Cotter and Jefferson City dolomites, the Roubidoux Formation, and the Gasconade and Eminence dolomites. Groundwater flow within this aquifer system in Cherokee County is to the west. The aquifer recharges in the east in Missouri where the aquifer units outcrop.

The Ozark aquifer is the primary source of water for the public, industrial, domestic, and stock supplies within the county. Deteriorating water quality in the deep aquifer system prompted the plugging of 26 deep wells in the Baxter Springs and Treece areas as part of Tar Creek remediation (Dames & Moore, 1993).

Both aquifer systems exhibit confined conditions except in the eastern portion of the county where the host rocks (Mississippian-aged) for the Springfield aquifer are exposed at the surface.

2.5 DEMOGRAPHY

In 2014, the U.S. Census Bureau estimated the population of Cherokee County to be 20,787 people. This is a 3.8 percent decrease in population from the 2010 Census. At the time of the 2010 Census, Cherokee County had a population of 21,603 people and 7,936 households. Of these, 30.5 percent of the households had an individual under 18 years of age (U.S. Census Bureau, 2014) as follows:

- 1,398 (6.5 percent) were under age 5,
- 1,512 (7.0 percent) were 5 to 9 years old,
- 1,586 (7.3 percent) were 10 to 14 years old, and
- 1,436 (6.6 percent) were 15 to 19 years old.

The effects of lead poisoning are most prominent in children under the age of 6, and this is the demographic of most concern for this investigation.

The 2014 Census reported that Cherokee County encompassed 588 square miles with a population density of 36.8 persons per square mile. The average household size was 2.65 persons. The median age for women was 41.7 years and the median age for men was 39.3 years. The total population median age was 40.5 years. The distribution of races that reside in Cherokee County are listed below by percentage (highest to lowest).

- 90.7 percent - White
- 4.1 percent - American Indian and Alaska Native
- 2.1 percent - Hispanic or Latino of any race

- 2.0 percent - Other Race
- 0.7 percent - Black or African American
- 0.4 percent - Asian

2.6 LAND USE

Land use throughout the Cherokee County Site OUs is approximately 60 to 70 percent agricultural - both row crops and pasture land (Dames and Moore, 1993). Rural light industry and commercial facilities are scattered throughout the Site, but clustered primarily around the largest community of Baxter Springs. The 1993 RI Report provides additional details of sitewide land use (Dames & Moore, 1993).

The rail lines include sections of active railroad traffic and lines that are no longer in service in various stages of disrepair. Some inactive sections are privately owned and are situated in rural or residential settings. Section 3 discusses the classification of the rail lines investigated as part of the RI.

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3.0 STUDY AREA REMEDIAL INVESTIGATION ACTIVITIES

This section describes the sampling conducted during the RI field activities to meet the RI objectives defined in Section 1.2. Field activities were conducted in 2013 during three separate events sequenced to accommodate access from property owners and the Burlington Northern Santa Fe (BNSF) railroad company: May 8, 9, and 10; June 10, 11, and 12; and December 2, 3, and 4.

Field activities conducted during the RI included:

- Inspection and classification of condition of rail lines in the OU8 study area;
- Excavation of test pits across the rail line ballasts to determine the fill/native soil interface and allow at-depth sampling;
- Collection of surface and subsurface soil samples for field screening using a field-portable XRF spectrometer; and
- Collection of confirmation samples for analysis by the EPA Region 7 Laboratory.

Generally, field activities were conducted according to the Sampling and Analysis Plan (SAP) (HGL, 2013b). Section 3.5 discusses deviations from the SAP. Appendix B provides photographic documentation of the field activities.

It should be noted that the RI scope of work did not include collection of groundwater or surface water and sediment samples. These media will not be discussed further in this report.

3.1 INSPECTION AND CLASSIFICATION OF RAIL LINES

On March 7 and 8, 2013, HGL and EPA inspected former rail lines within OU8, classified the condition of the beds and the surrounding areas, identified locations for subsequent test pits and sampling, and identified property owners for initial access activities (HGL, 2013a). Rail lines were classified by the condition of the beds and the surrounding areas, as follows:

- Class 1 lines were beginning to deteriorate and there was no evidence of ties, or they were broken down, and there was some weathering of the rail bed (but the topography of the rail bed was visible).
- Class 2 lines were deteriorated with no ties, and the rail bed is discontinuous, or has been weathered extensively.

The former rail lines also were classified on whether the surrounding area was rural, either agricultural or wooded with little or no human exposure, or residential.

Based on the findings of the field reconnaissance, a map was assembled showing locations where the classification was confirmed by on-site reconnaissance as well as assumed classifications of rail line segments based on nearby confirmed classifications. An interim report of the site visit for inspection and classification of rail lines was submitted to EPA to guide subsequent sampling efforts (HGL, 2013a).

3.2 PROPERTY ACCESS

Property access was obtained through access agreements signed by either the property owner (for abandoned segments that reverted to private ownership, or from BNSF (for segments retained by the company). HGL mailed EPA access agreements to the private property owners identified as owning abandoned rail lines. Access for BNSF-owned rail lines was coordinated through their contractor at Jones Lang LaSalle America, Inc., and was approved in October, 2013. Whenever possible, existing access agreements in the other OUs for the Site were used.

3.3 SURFACE AND SUBSURFACE SOIL INVESTIGATION

3.3.1 Sample Collection and Preparation

Test pits were excavated with a backhoe across the rail ballasts at 34 locations identified during the reconnaissance (see Section 3.1). The 34 test pit sample locations were selected to represent varying rail bed conditions, classification, and geographical locations across the site. A total of 102 test pits were excavated. At each test pit location, grab samples were collected at 6-inch intervals from the surface to a depth of 4 feet (48 inches) (Figures 3.1 through 3.4). Depending on the location, one to five test pits were excavated and sampled. The test pit number (e.g. Test Pit 2A) corresponds with the sample location on the figures. The alphabetic (e.g. A) designation indicates a particular test pit at sample location 2 (in this example). There were 68 primary (parallel to the rail bed) test pits and 34 lateral (perpendicular to the rail bed) test pits. It should be noted that some sample locations did not have lateral test pits, while other locations had multiple lateral test pits.

The first day of sampling, soil from each interval was collected from the backhoe bucket, placed in a disposable aluminum pan, homogenized, and transported to the vehicle for XRF field screening. This process was modified after the initial day of sampling: the samples were collected from the bucket, placed into plastic bags and homogenized, then sealed. Using a plastic bag rather than a pan allowed the samples to be more easily transported to the field vehicle for XRF screening, and with less potential for cross contamination among other samples. Each bag was labeled with the alphanumeric test pit location and sample depth interval. XRF screening of the 587 samples collected from the test pits are discussed in Section 3.3.2.

Primary test pits were oriented parallel to the rail bed. The SAP proposed that at half the test pit/sampling locations, lateral test pits be excavated perpendicular to the rail bed to visually assess how far the ballast extended from the center of the rail bed and its thickness. At some test pit locations, it was not possible to excavate laterally from the rail bed centerline due to the presence of heavy overgrowth or water-filled drainage ditches. Where possible, the sample was collected at a location lateral from the rail bed centerline where there was no visible chat. These samples were collected using a shovel from the 0 to 6-inch and 6 to 12-inch interval to determine whether a clean boundary was located. The distance from the centerline of the rail bed was recorded for each of the lateral sample locations.

After the samples were collected, each test pit was backfilled with the excavated material and tamped into place using the backhoe bucket.

The backhoe bucket and shovel was decontaminated between Test pit locations, in accordance with the procedures outlined in the SAP (HGL, 2013b). The sampling supplies were disposable single-use materials.

It should be noted that the RI did not include a site-specific background study to determine naturally occurring levels of the metals of concern in soil in Cherokee County. Previous background soil sample data are discussed in Section 5

3.3.2 Field Screening

The 587 surface and subsurface soil samples were screened in the field using a portable Niton™ XRF instrument supplied by EPA. The analytical method employed was EPA Method 6200 *Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment* (EPA, 2007).

Three XRF readings and their respective uncertainty values were recorded, averaged, and documented for the metals cadmium, lead, and zinc at each interval. Uncertainty values were expressed as a +/- error value. In accordance with the SAP, all three readings had to be within 10 percent of each other; otherwise, the sample was remixed and XRF readings taken until the ± 10 percent criteria was achieved. If the concentration was below the instrument level of detection, the “<” symbol was recorded along with the detection level.

The XRF calibration was confirmed with check standards at the beginning of each day, and when the battery on the unit was changed. Appendix C provides a table of the standards and calibration check results. Further description of daily QC checks are discussed in Section 4.5.2 of the EPA-approved SAP (HGL, 2013b). The field screening results are discussed in Section 5.

3.3.3 Confirmation Samples and Data Correlation

The suitability of XRF data for use in decision-making was assessed by submitting confirmation samples and evaluating the correlation of XRF data to fixed-lab data. Confirmation samples were collected from the same homogenized material as the associated field screening sample, packed in 8-ounce jars, labeled, and submitted to the EPA Region 7 laboratory.

From the 587 samples screened on site, 76 samples (including field duplicates) were submitted for confirmation analysis. This represents 12.9 percent confirmation of the samples screened in the field, which exceeds the 10 percent prescribed in the EPA-approved SAP. Confirmation samples were selected to represent a range of XRF readings from highest to the lowest lead concentrations. Confirmation samples were analyzed by the EPA Region 7 laboratory using EPA SW846 Method 6010C for cadmium, lead, and zinc. Table 3.1 provides a summary of the confirmation samples, which included duplicates. The field sheets and chain of custody (CoC) records for the confirmation samples are provided in Appendix D.

Field QC consisted of the collection and analysis of duplicate samples for confirmation analysis. Nine field duplicate samples were collected for laboratory analysis, which is 11.8 percent of the 76 total confirmation samples. This exceeds the 10 percent required by the SAP (HGL, 2013b). All duplicate samples were uniquely identified and documented in the field logbook and on field sheets. The QA/QC program for the RI is discussed in detail in Section 4.0.

The relationship between the lead XRF and laboratory data was evaluated by calculating the correlation coefficient (r^2) between the XRF result and laboratory result. According to EPA Method 6200 employed for the XRF screening, an r^2 of at least 0.7 is considered to be acceptable screening level data. Appendix E Table E.1 provides the laboratory and field screening data for comparison. Appendix E Figure E.1 shows the regression analysis of the XRF and confirmation datasets. As shown on the figure, r^2 was 0.821 for the correlation between the laboratory and field screening data. It should be noted that the data was log-transformed to standardize the variance, as directed by EPA Method 6200 because the data for the field XRF screening measurements and the laboratory data each spanned more than an order of magnitude.

3.4 INVESTIGATION-DERIVED WASTE HANDLING AND DISPOSAL

Investigation-derived waste (IDW) generated during the field activities consisted of disposable or expendable materials such as single-use sampling supplies and gloves. These items were placed in garbage bags for disposal as household solid waste. No soil IDW was generated—soil collected from the test pits was returned to the collection location, unless it was submitted to the laboratory for analysis.

3.5 DEVIATIONS FROM THE SAMPLING AND ANALYSIS PLAN

Sample collection deviations from the EPA-approved SAP (HGL, 2013b) that occurred during the RI/FS field activities are as follows:

- The SAP estimated sample collection from approximately 100 locations. Based on the findings of the site reconnaissance and property access, 34 locations were selected with EPA approval. Depending on the conditions at each location, 1 to 5 test pits were excavated at each sampling location.
- Lateral test pits were planned at the projected 100 sampling locations. Because of heavy vegetation, standing water, and the reduced number of sampling locations, 34 lateral test pits were excavated (see Section 3.3.1).
- Fewer test pits were required than those initially planned because of the consistent nature of the materials found within the rail beds at most locations.

4.0 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

This section describes the QA/QC program utilized during the RI/FS. The data quality objectives (DQOs) are described in the 2013 *Generic Quality Assurance Project Plan (QAPP) for Region 7's Superfund Lead Contaminated Sites* (EPA, 2013), which is included in the SAP (HGL, 2013b). Key components of the QA/QC program include sample tracking and management, field QC, data management, and laboratory QC. The usability and applicability of the RI/FS data can be determined through evaluation of RI/FS activities from sample collection to laboratory analyses against the requirements of the various aspects of the QA/QC program. The overall quality of the data collected is presented in the data quality evaluation (DQE) in Section 4.5. The following sections discuss each aspect of the QA/QC program.

4.1 FIELD QUALITY CONTROL

During the RI, field QC samples were collected to evaluate sampling techniques as specified in the SAP. Sample labels were preprinted to facilitate sample tracking from the field, through the laboratory, to the final report. Documentation of sample collection was performed in the field to ensure that sample labeling and request for analyses were in agreement and traceable back to the correct field sample. In accordance with the SAP, the field QC samples consisted of field duplicates of confirmation samples as described below.

A field duplicate is a second sample collected in the same location as a field ("parent") sample. Duplicate samples are collected simultaneously, or in immediate succession, to the parent sample, using identical recovery techniques. The parent and duplicate are treated in an identical manner during transportation, storage, preparation, and analysis. Duplicate sample results are used to assess the precision of the sample collection process and the representativeness of the sample matrix. Field duplicate samples were labeled using the parent sample identification (ID) with an "FD" suffix. For the soil samples, field duplicates were collected as a split fraction of the samples, rather than co-located.

Matrix spike (MS)/matrix spike duplicate (MSD) samples were assigned by EPA Region 7 Laboratory from the samples submitted to the laboratory by field personnel.

4.2 SAMPLE TRACKING PROTOCOL

4.2.1 Sample Identification

Since all samples were being analyzed by the EPA Region 7 laboratory, a unique identifier for tracking and management purposes was pre-assigned and preprinted on sample labels. The sample numbers consisted of the Analytical Services Request (ASR) number, and a sequential number for each sample (1, 2, etc.). Field duplicates were identified with an "-FD" at the end of the ASR and sample numbers.

The location of each sample, as well as time and date of sample collection and requested analyses were recorded on a field sheet completed for each sample. An alphanumeric coding system was used to identify each sample location as outlined in the SAP (HGL, 2013b) with minor adjustments once in the field. An example sample designation follows:

CCR - SO – 2A – 6-12

CCR = Cherokee County Railroads Site
SO = Surface soil sample or SS for subsurface sample
2A = test pit location
6-12 = the 6-inch interval from which the sample was collected.

Field duplicate associations for confirmation samples were recorded by the Field Team Leader in the field logbook and on the appropriate field sheets.

4.2.2 Documentation of Field Activities and Sample Collection

All identification and tracking procedures for samples were conducted in accordance with Section 5 of the SAP. The alphanumeric coding system detailed in Section 4.2.1 above was employed to uniquely identify each sample collected during the field investigation. For samples that were shipped to the EPA Region 7 laboratory for analysis, sample numbers were pre-assigned by EPA Region 7 laboratory personnel and preprinted on sample labels. The sample numbers consisted of a number designating the ASR number, and a sequential number for each sample (1, 2, etc.).

The location of each sample, time and date of sample collection, and requested analyses, were recorded on a field sheet completed for each sample. CoC forms were used to identify, track, and monitor each individual sample from the point of collection through final data reporting. Appendix D provides the field sheets and CoC records.

4.3 DATA MANAGEMENT

The data used to prepare the RI report were obtained from a combination of sources, including XRF screening results and fixed laboratory analytical data. The process of data gathering was a coordinated effort by project staff in conjunction with all data producers. The fixed laboratory data generated during this sampling event was obtained from the EPA Region 7 laboratory in the form of an electronic data deliverable (EDD) in addition to the required hard copy analytical data package (Appendix F). The standard data management software is SCRIBE for all analytical data to be submitted electronically by HGL.

The laboratory data was used in the preparation of the RI and baseline HHRA and ERA reports prepared by EPA. As a part of the QC review procedures for preparation of this RI Report, the data has been further checked by technical reviewers and a QC Coordinator to verify its accuracy in the RI Report.

4.4 LABORATORY QUALITY CONTROL

The laboratory QC program, including sample handling, laboratory QC elements, and data reporting, was conducted in accordance with the EPA Region 7 Generic QAPP for Superfund Lead-Contaminated Sites (EPA, 2013). In addition, HGL completed a QAPP Addendum to address site-specific elements within the Generic QAPP. The addendum and EPA Generic QAPP were provided as Appendix A of the SAP (HGL, 2013b)

Sample handling includes documentation of sample receipt, placement in storage, controlled sample access, and disposal. Laboratory QC elements consist of instrument calibration and maintenance, laboratory control samples (LCSs), method blanks, MS/MSD samples, and method-specific QC checks.

4.5 DATA QUALITY EVALUATION

This section describes the DQE of analytical results of samples collected during the RI. The objective of the DQE is to provide a professional evaluation of the analytical data packages submitted by the laboratory. The DQE includes a review of laboratory and field QC data, and an overall evaluation of data labeled as usable, usable with qualification, and unusable. The following qualifiers were used during the data validation process:

J = The identification of the analyte is acceptable; the reported value is an estimate.
U = The analyte was not detected at or above the reporting limit.

Analytical results of environmental and QC samples submitted for analysis to the EPA Region 7 laboratory were received by HGL as validated data. Field QC performance was assessed through the evaluation of field duplicates, documentation, and sample handling.

The DQE for each analytical procedure is presented in the subsections below. Each subsection identifies the number of results determined to be unusable and those results that were usable with qualification. There were no rejected results.

4.5.1 EPA Region 7 Laboratory Data

Analytical data reports were received from the EPA Region 7 laboratory in both hard copy and EDD format. EPA validates its own data prior to providing it to HGL. The HGL project chemist performed a quality check of the EPA results by reviewing sample numbers versus CoC forms and EPA field sheets for consistency and completeness. The qualifiers added by the EPA validator were reviewed to determine usability of the results, as were the results of field QC samples.

4.5.1.1 Metals

Soil samples were analyzed (SW846 Methods 6010C) for lead, zinc, and cadmium using the EPA Contract Laboratory Program (CLP) method. In total, 76 metals samples were generated. All the samples submitted for analysis were analyzed within the hold times. The overall completeness of the EPA laboratory metals analyses was 100 percent, which is acceptable for the soil samples.

4.5.1.2 Field Duplicates

Nine field duplicate pairs were submitted to the Region 7 EPA Laboratory for lead, zinc and cadmium analysis. No data were rejected due to field duplicate outliers. A summary of all duplicate pairs can be found in Appendix G Table G.1.

4.6 QUALITY CONTROL ELEMENTS

Analytical data packages were received from the EPA Region 7 laboratory in both hard copy and EDD format. Though EPA validated its own data prior to providing it to HGL, HGL reviewed the validated data packages for consistency and completeness. The qualifiers added by the EPA validator were reviewed by HGL to determine the usability of the results. HGL also evaluated the results of field QC samples (field duplicates of confirmation samples) submitted to the EPA Region 7 laboratory for analysis. Data were evaluated against the PARCCS parameters of precision, accuracy, representativeness, completeness, comparability, and sensitivity. Laboratory QC elements was conducted by EPA and was not evaluated by HGL.

4.6.1 Precision

Precision measures the reproducibility of a measurement. It is strictly defined as the degree of mutual agreement among independent measurements, resulting from repeated application of the same process under similar conditions. Analytical precision is the measurement of variability associated with duplicate (two) or replicate (more than two) analyses. EPA uses laboratory control samples (LCSs) to determine the precision of an analytical method. If analyte recoveries in an LCS are within established control limits, then precision is within control limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the sample batch, rather the comparison is between the sample and samples analyzed in previous batches. Total precision is the measurement of variability associated with the entire sampling and analysis process, determined by analysis of duplicate or replicate field samples, and measures variability introduced by both the laboratory and field operations. Field duplicate/replicate samples and MS/MSDs are analyzed to assess field and laboratory precision. For duplicate samples, precision is calculated using the relative percent difference (RPD) between the results, whereas for replicate analyses the relative standard deviation is determined. The acceptable RPD limit for duplicates submitted to the EPA Region 7 laboratory is 25 percent as specified in the Generic QAPP (EPA, 2013).

Nine duplicate sample pairs were submitted for this project, yielding 27 total duplicate analytical sample results (data pairs). Of these 27 results, 10 exceeded the RPD limit of 25 percent. Appendix G provides the duplicate sample pair RPD calculations. The overall completeness for the data is 63 percent, indicating that the DQO for precision established in the QAPP (90 percent) was not achieved. This issue with precision between parent and duplicate sample results is likely to have occurred because sample material was not pulverized and sieved before being split into the sample duplicate pair. This sampling approach can have a significant effect on sample precision.

4.6.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and system error. Accuracy, therefore, reflects the total error associated with a measurement. A measurement is considered accurate when the value reported does not differ from the true value or known concentration of the associated spike or standard, within prescribed control limits. Analytical accuracy is measured by comparing the percent recovery of analyte spiked into an LCS to a control limit. No data were rejected for this project due to LCS exclusions−the DQO for accuracy established in the QAPP for this project was achieved.

4.6.3 Representativeness

Objectives for representativeness are defined for each sampling and analysis task and are a function of the investigation objectives. Representativeness is achieved through use of standard field sampling and analytical procedures. Representativeness is also determined by appropriate program design and consideration of project elements, such as proper sample and test pit locations, and sampling procedures, and sample intervals. Therefore, the results from field and laboratory blanks are evaluated to determine whether analytes detected in environmental samples are representative of the sampled matrix and not artifacts of the sampling and/or analysis processes.

Additionally, nine field duplicate sample pairs were collected to assess the effect of sample collection on results. For all analyses, 63 percent (17 out of 27) of the analytes in field duplicate sample pairs met RPD evaluation criteria. The representativeness goal of 90 percent established in the QAPP was not achieved for this project. The PARCCS parameters of representative and precision (see section 4.6.1) are the parameters most affected by inhomogeneity of the sample matrix. Because the samples were not pulverized and sieved to improve homogeneity before analysis, 37 percent of the duplicate pair results did not meet RPD the representativeness goal, as expressed by the RPD calculations. However, the data showed generally similar concentrations within the sampled chat, and decreasing levels of contamination with depth across the test pits at most locations. This indicates that the RI analytical data is generally representative of site conditions.

4.6.4 Completeness

Completeness is calculated for all data associated with a particular analyte of interest measured during an individual sampling event or a different defined set of samples. The number of valid analyte results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of a dataset. In evaluating the completeness of a sampling event, valid results are all results not qualified with an "R" qualifier. The project requirements for completeness are 90 percent for all analytical data. For instances in which samples could not be analyzed (for example, holding time violations where resampling and analysis were not possible, samples spilled or broken), the numerator of this calculation becomes the number of valid results minus the number of results not reported.

The formula for calculating completeness is as follows:

$$\%\ \text{completeness} = \frac{\text{number of valid (i.e., non-R qualified) results}}{\text{number of possible results}} \times 100$$

Soil samples delivered to the EPA Region 7 laboratory generated a total of 228 soil data points (from environmental samples and field duplicates); all of these data points were considered usable. Overall completeness was calculated to be 100 percent, which meets the DQO for soil samples.

4.6.5 Comparability

Comparability is the confidence with which one dataset can be compared to another dataset. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices sampled and the range of field conditions encountered are considered when determining comparability. Comparability is achieved by standardizing sampling methods, analytical methods, reporting units, and the format of report submittals. Field documentation using standardized data collection forms supports the assessment of comparability.

4.6.6 Sensitivity

Analytical sensitivity is important in providing comparisons of analytical reporting limits (RLs) achieved by the laboratories with project DQOs. For this project the DQO for soil samples was established as the November 2015 Regional Screening Level (RSL) for Residential Soil using the lower of a hazard quotient (HQ) of 0.1 and cancer risk of 1E-06. Section 5.1.2 discusses these preliminary remediation goals. RLs must be low enough to allow both detected and nondetected results to be compared with the applicable DQOs. RLs achieved by the EPA Region 7 laboratory were sufficient for the three metals analyzed. The metals of potential concern in soil and the screening levels used to evaluate RI results are shown in the table below in comparison.

Soil Screening Values

Metal	Residential Soil RSL[1] (mg/kg)	Lab Reporting Limit (mg/kg)
Cadmium	7.1	0.43U – 1.5U
Lead	400[2]	NA
Zinc	2,300	NA

[1] Residential Soil RSLs with HQ of 0.1 are from EPA Regional Screening Levels Summary Table, November 2015.
[2] Lead is evaluated through blood lead modeling. The EPA residential soil screening level of 400 mg/kg is calculated to be protective of the child resident receptor.
mg/kg = milligrams per kilogram
NA = Not available. Metal was detected in every sample. Thus, the reporting limit was not listed.
RSL = EPA Regional Screening Level.
U = The analyte was not detected at or above the associated reporting limit.

RLs vary because it is the lowest level at which a laboratory can report an analyte detection with quantitative significance. Each instrument used for analysis may have different RLs because the method, analyte, and matrix are factored into determining the quantitative significance. The laboratory RLs for cadmium are sufficient to identify chemicals of potential concern (COPCs) for HHRA.

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5.0 NATURE AND EXTENT OF CONTAMINATION

This section addresses the nature and extent of contamination identified in the rail beds by reviewing the sources of contamination and describing the vertical and horizontal extent of contamination in soil at the sample locations situated in and along the rail beds comprising OU8. Defining the nature and extent of contamination is dependent on obtaining sufficient quantitative data to characterize contamination in affected media. Once the nature and extent of contamination is defined, contaminant fate and transport mechanisms can be determined, leading to the development of a site-specific risk assessment that evaluates potential exposure pathways. The risk assessment and determination of the physical site conditions forms the basis for the evaluation of appropriate remedial alternatives in the FS, and selection of a preferred remedy in the ROD.

Test pits were completed and samples collected at various locations in and adjacent to rail beds at various locations throughout the site area. Analytical results and visual observations were used to determine if there was consistency in the depth of the chat layer and if contamination had migrated into the native soil. Rail lines traversed both rural and residential areas.

5.1 COMPARISON CRITERIA

5.1.1 Background Soil Concentrations

The RI used background data obtained as part of the RI conducted by Dames & Moore in 1993. For this background study, background samples were collected to evaluate 17 metals, including cadmium, lead, and zinc, from five locations near Baxter Springs and three locations near Treece. The samples were collected from depths of 14 to 24 inches at locations that did not exhibit the presence of visible chat from chat-covered roads or mill wastes from neighboring deposits. Table 5.1 provides the background soil results and average concentration for each of the three metals. Appendix H provides the background sampling text and figures of the sample locations in each area (Dames and Moore, 1993).

Because there were no surface soil background samples collected during the 1993 RI, the surface soil analytical results from the current RI also were compared the background subsurface sample dataset. The average background concentrations were compared against their respective EPA RSLs for Residential Soil provided in Table 5.1. This comparison shows that the three metals identified as COPCs at the site do not have background levels that exceed the RSLs. Therefore, the analytical results for the soil samples collected from the test pits primarily will be compared to the RSLs.

5.1.2 Preliminary Remediation Goals

The preliminary remediation goals for the Site are the EPA RSLs for Residential Soil equal to the lower of an HQ of 0.1 and cancer risk of 1E-06. The HQ is adjusted to account for potential additivity among site contaminants. The lead RSL is based on blood lead modeling to achieve a blood concentration protective of children, who are the most sensitive receptor to this contaminant.

5.2 SOURCES OF CONTAMINATION

The primary source of contamination for the CCR OU8 site is mining activities such as excavation and transport of the material; ore refinement processes; and creation of chat, tailings, and other wastes resulting from the refinement process. The contamination migrated to the rail beds in OU8 by using chat as rail bed ballast. The sources of the contamination have been documented during previous investigations; therefore, no source samples were collected for the RI. The nature and extent of contamination in the rail beds are discussed below in Section 5.2.

5.3 SOIL SAMPLE ANALYTICAL RESULTS

The analytical results and physical conditions at each test pit sample location are illustrated on Figures 5.1 through 5.33. Each figure contains a graph illustrating the average metals concentrations at each interval, the soil classification, and a table with the sample concentrations for all intervals in each test pit associated with the location. The test pit number (e.g. Test Pit 2A) corresponds with the sample location on Figures 3.1 through 3.4. The alphabetic (e.g. A) designation indicates a particular test pit at sample location 2 (in this example). Appendix I Table I.1 provides a summary of the average XRF readings for the 587 samples that were screened in the field.

The XRF readings for each sample were compared to the Residential Soil RSL (EPA, 2015) for cadmium, lead, and zinc. Tables 5.2, 5.3, and 5.4 compare soil sample concentrations to the RSLs for cadmium, lead, and zinc, respectively.

5.3.1 Surface Soil

Surface soil data discussed in this section refers to the 101 samples collected from the 0- to 6-inch interval and field screened with the XRF. The analytical results for each of the three metals identified as COPCs are discussed below. The surface soil samples in all cases consisted primarily of weathered chat material, not native soil.

5.3.1.1 Cadmium

Cadmium was detected in 67 of the 101 samples screened during the RI sampling event (Table 5.2). All 67 detections exceeded the Residential Soil RSL (HQ = 0.1) of 7.1 mg/kg. Field screening concentrations in surface soils ranged from 14 mg/kg to 66 mg/kg. The highest concentration was detected in Test Pit 5B-S (Figure 5.5). The analytical data (Table I.1 in Appendix I) does not indicate that there are cadmium hotspots in particular segments of the OU8 rail beds. Rather, the field screening results show that widespread cadmium contamination is present in the rail bed material exposed at the ground surface. In general, samples with the highest cadmium levels also contained the highest zinc concentrations. This trend was less noticeable in comparison to the lead dataset.

It should be noted that the cadmium detection limit for the XRF exceeded the Residential Soil RSL (HQ = 0.1) in all 34 samples reported as nondetect for the metal.

Cadmium was detected in all 10 of the samples submitted to the laboratory for confirmation sampling at levels ranging from 8.9 mg/kg to 48.2 mg/kg (Appendix F). All confirmation cadmium concentrations exceeded the Residential Soil RSL (HQ = 0.1).

5.3.1.2 Lead

Lead was detected in 99 of the 101 surface soil samples (Table 5.3). Field screening concentrations ranged from 13 mg/kg to 2,271 mg/kg. The Residential Soil RSL for lead of 400 mg/kg was exceeded in 44 of the samples (Table 5.3). The highest concentration was detected in Test Pit 9B (Figure 5.9). The southwest corner of the site area where sample locations 1 to 8 are situated had 7 of the 11 samples with the highest lead levels (over 1,000 mg/kg) observed during the sampling effort. In particular, higher surface soil lead contamination was observed in select test pits at locations 3 and 5 (Figures 5.3 and 5.5). But, it should be noted that lead detections above the Residential Soil RSL were widespread in the site area. The field screening dataset provided as Table I.1 in Appendix I shows limited correlation between the highest lead detections and the highest cadmium and zinc concentrations.

Lead was detected in all 10 of the samples submitted to the laboratory for confirmation sampling at levels ranging from 265 mg/kg to 884 mg/kg (Appendix E, Table E.1). Lead concentrations in 6 of the 10 samples exceeded the Residential Soil RSL.

5.3.1.3 Zinc

Zinc was detected in all 101 surface soil samples screened during the RI event, and concentrations in 71 samples exceeded the Residential Soil RSL (HQ = 0.1) of 2,300 mg/kg (Table 5.4). Field screening concentrations ranged from 55 mg/kg to 20,467 mg/kg. The highest concentration was detected in Test Pit 29A (Figure 5.29). The analytical data does not indicate that there are zinc hotspots in particular segments of the OU8 rail beds. As with cadmium, the field screening results show that widespread zinc contamination at levels exceeding the Residential Soil RSL (HQ = 0.1) is present in the rail beds in the material exposed on the ground surface.

Zinc was detected in all 10 of the samples submitted to the laboratory for confirmation sampling at levels ranging from 1,600 mg/kg to 12,600 mg/kg (Appendix F). The concentrations in 9 of the 10 confirmation samples exceeded the Residential Soil RSL (HQ = 0.1).

5.3.2 Subsurface Soil

Subsurface soil data discussed in this section refers to the 486 samples collected from the 6-inch to 48-inch interval. As previously discussed, the samples were collected for screening in 6-inch increments across the subsurface interval. The subsurface soil samples consisted of weathered chat to a depth of about 30 inches where the material generally transitioned to native soil. Native soil in the 102 test pits was encountered at depths ranging from 6 inches to below 48 inches bgs (target depth). Figures 5.1 through 5.33 provide a bar graph for the primary test pits showing the depth at which native soil was encountered.

5.3.2.1 Cadmium

Table 5.2 provides ranges of cadmium concentrations for each sample depth and a comparison to the Residential Soil RSL (HQ = 0.1). Cadmium was detected in 238 of the 486 subsurface field screening soil samples at concentrations ranging from 13 mg/kg to 79 mg/kg. All 238 detections exceeded the Residential Soil RSL (HQ = 0.1) of 7.1 mg/kg. The highest concentration was observed in Test Pit 27B in the 24 to 30-inch interval (Figure 5.27).

In general, the highest cadmium concentrations were observed above a depth of 30 inches, where the chat typically transitioned to native soil. In the 25 samples with the highest detections (those greater than 50 mg/kg), only 2 samples were collected below 30 inches. One of these two samples was collected from Test Pit 27B where the overall highest cadmium detection was observed. It is expected that the chat material from mining activities, which was generally observed above 30 inches, would have higher metals concentrations than the native soil below. As with the surface soils, cadmium contamination is widespread throughout the site area.

Cadmium was detected in 63 of the 66 subsurface soil samples submitted to the laboratory for confirmation analysis at levels ranging from 0.63 J mg/kg to 113 mg/kg (Appendix F). The cadmium detections in 57 of the confirmation samples exceeded the Residential Soil RSL (HQ = 0.1) for cadmium.

5.3.2.2 Lead

Table 5.3 provides ranges of lead concentrations for each sample depth and a comparison to the Residential Soil RSL. Lead was detected in 419 of the 486 subsurface field screening soil samples at concentrations ranging from 7 mg/kg to 16,533 mg/kg. Lead detections in 152 of the samples exceeded the Residential Soil RSL of 400 mg/kg. The highest concentration was observed in Test Pit 13C in the 24 to 30-inch interval (Figure 5.13B).

In the 31 subsurface samples with the highest lead concentrations (those greater than 1,500 mg/kg) 9 samples were collected below 30 inches. The highest lead level of 2,013 mg/kg observed in the deepest sample interval (42 to 48 inches) was observed in Test Pit 29B where chat extended the full depth of the pit (Figure 5.29). The highest lead detections were generally observed above a depth of 30 inches, although the percentage of lead samples from below 30 inches above the 1,500 mg/kg threshold was higher than for either cadmium or zinc. Spatially, the lead contamination Residential Soil RSL generally was widespread in the OU8 rail beds that were sampled, and no localized hotspots were apparent.

Lead was detected in all 66 subsurface soil samples submitted to the laboratory for confirmation analysis at levels ranging from 7.3 mg/kg to 4,260 mg/kg. In 35 of the 66 confirmation samples, the lead concentration exceeded the Residential Soil RSL.

5.3.2.3 Zinc

Table 5.3 provides ranges of zinc concentrations for each sample depth and a comparison to the Residential Soil RSL (HQ = 0.1). Zinc was detected in all 486 field screening subsurface soil samples at concentrations ranging from 18 mg/kg to 30,050 mg/kg. Zinc detections in 216 of the field screening samples exceeded the Residential Soil RSL (HQ = 0.1) of 2,300 mg/kg. The highest concentration was observed in Test Pit 17B in the 12 to 18-inch interval (Figure 5.17).

As with cadmium, the highest zinc detections were generally observed above a depth of 30 inches.

In the 25 subsurface samples with the highest zinc concentrations (those greater than 15,000 mg/kg) only 1 sample was collected below 30 inches (Test Pit 13A). Zinc concentrations above the Residential Soil RSL (HQ = 0.1) are widespread, as with the other two metals. However, several of the highest zinc concentrations were observed in test pits at Sample Locations 17 and 18 near Riverton in the central part of the site area; and Sample Location 13-B (Figure 5.13b) on the north edge of Baxter Springs.

Zinc was detected in all 66 samples submitted to the laboratory for confirmation analysis at levels ranging from 13.9 mg/kg to 22,000 mg/kg. The lead concentration in 50 of the 66 confirmation samples exceeded the Residential Soil RSL (HQ = 0.1).

5.4 CONCLUSIONS

Analytical results indicate that the chat used as ballast material for the OU8 rail beds contained cadmium, lead, and zinc contamination above the Residential Soil RSLs adjusted for additivity of non-cancer effects. The chat is associated with mining activities in Cherokee County. Background subsurface soil concentrations for these metals are below their respective RSLs. Because subsurface soil background samples were not collected during the 1993 RI, the subsurface background levels also are used in this RI for comparison to surface soil sample results. Metals concentrations generally decreased in the samples of native soil collected beneath the chat if it was encountered above the target depth of 48 inches. Seven samples collected from the deepest sample interval (42 to 48 inches) contained one or more of the three metals above their respective Residential Soil RSL. In six of these seven pits where the samples were collected, the depth of the chat extended to the target depth of 48 inches.

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6.0 CONTAMINANT FATE AND TRANSPORT

This section provides a detailed discussion of the chemical and physical properties of the identified COPCs, their potential migration pathways, and the mechanisms of transport in the environment.

The CCR OU8 Railroads Site includes former rail lines that are not subsumed within one of the other OUs for the overall Cherokee County Site. The COPCs for the site are lead, cadmium, and zinc, which are associated with mining activities in the area. Lead is typically the primary COPC. The contamination primarily migrated to the former rail lines from the use of chat as ballast for the rail beds. Airborne particulates (dust) and suspended sediment in surface water runoff from mining waste piles that lie adjacent to the former rail lines in select areas may also have contributed metals contamination to the rail beds. The rail beds themselves also can be considered a secondary source area for possible contamination in areas surrounding the rail beds due to leaching into underlying native soil, surface water runoff and airborne dust.

This metals contamination may also enter surface water and groundwater through runoff and leaching into the subsurface. This RI and the subsequent FS are focused on the soils potentially impacted by the three mine waste COPCs identified for the site.

The following subsections present a general description of sorption (partitioning), volatilization, migration, degradation, and transformation processes to provide a basic understanding of the processes that affect the subsurface fate and transport of the identified preliminary COPCs associated with the site.

6.1 PHYSICAL AND CHEMICAL PROPERTIES OF METALS

The physical and chemical characteristics of constituents and the environmental media (air, water, soil, and sediment) in which they are present affect the mobility and persistence of the metals. Lead is naturally present in soil. Under most conditions lead reacts with clays, phosphates, sulfates, carbonate hydroxides, and organic matter to reduce its solubility. However, the formation of organic complexes may significantly increase the solubility of lead in soil. Above a pH of 6, most lead is bound in lead carbonate or adsorbed on clay surfaces (ATSDR, 2007).

Lead may bioaccumulate in the environment. Plants and animals may bioconcentrate lead, but biomagnification is not expected. The bioavailability of lead in soil to plants is limited because of the strong adsorption of lead to soil organic matter, but the bioavailability increases as the pH and the organic matter content of the soil are reduced. Plants grown in lead-contaminated soils were shown to accumulate low levels of lead in the edible portions of the plant from adherence of dusts and translocation into the tissues (Finster et al., 2004). Lead may be taken up in edible plants from the soil via the root system, by direct foliar uptake and translocation within the plant, and by surface deposition of particulate matter. The amount of lead in soil that is bioavailable to a vegetable plant depends on factors such as cation exchange capacity (CEC), pH, amount of organic matter present, soil moisture content, and type of amendments added to the soil. Organisms higher up the food chain, such as avian species, may experience lead poisoning as a result of eating lead-contaminated food. Two characteristics greatly affect the fate and transport of a metal in the environment: solubility and partitioning.

Water solubility is the maximum concentration of a compound that will dissolve in a unit volume of pure water at a given temperature and pH. It is a fundamental parameter affecting the environmental transport of a chemical. Those that are highly soluble in water tend to be mobile in aqueous systems (for example, migrate readily with groundwater flow or be in the aqueous phase of surface water systems) and tend to leach readily from soil. Metals generally, and lead specifically, have low water solubility, resulting in limited ability to dissolve in surface water or groundwater under ambient conditions. They tend to partition out of the aqueous phase onto organic matter. Accordingly, they exhibit limited leaching potential, and tend to migrate or be adsorbed to soil or sediment particles as described below.

Focusing on the primary COPC, the solubility of lead is 10 parts per billion (ppb) above pH 8, while near pH 6.5 its solubility can approach or exceed 100 ppb (ATSDR, 2007). At slightly acidic pH, lead can dissolve from already-bound particulate matter.

Partitioning is generally measured by the overall partition coefficient, which is the ratio of the solid phase concentration (for example, soil or sediment concentration) to the aqueous concentration. It indicates that, for a given compound, more mass will sorb to a solid with a high organic content as compared to a solid with low organic carbon content. The affinity of a chemical for sorption on natural organic matter is expressed by its carbon/water partition coefficient (K_{oc}). Chemicals with low K_{oc} values (less than 10 milliliters per gram) are found mainly in the water phase. Lead has a high K_{oc} and is more likely to become fixed to organic matter within the soil matrix. The amount of naturally occurring organic carbon present in a soil affects the adsorption of organic compounds in that soil. The greater the organic carbon content in the soil, the more likely it is that the organic compounds migrating through the soil will become adsorbed by the organic component of the soil.

Metals, however, do not partition in the same manner as organic compounds. Metals may associate with soil or sediment particles through a number of processes, such as chelation with organic matter, adsorption onto a mineral surface, and precipitation. The occurrence of these processes depends on the valence state of the metal, which in turn is affected by pH and oxidation-reduction potential. In general, metals tend to be less mobile under oxidizing conditions than reducing conditions. This is specifically true for lead, the primary COPC.

The general insolubility in water and tendency to adsorb to soil and organic particles suggest that metals are not influenced by functions such as advection, dispersion, hydrolysis, and others that typically play a major role in the fate and transport of organic compounds. Metals, therefore, tend to be immobile and persistent in the environment.

The COPC metals associated with the CCR OU8 Site are discussed below. The conceptual site model (CSM) is provided as Figure 6.1

6.1.1 Preliminary COPC Metals

All soils contain trace amounts of metals that are naturally occurring in the Earth's crust. The three preliminary COPC metals for the CCR OU8 Site and the matrices in which they occur are listed in the table below.

Preliminary Chemicals of Potential Concern

Preliminary COPC	Matrix	
	Surface Soil	Subsurface Soil
Cadmium*	X	X
Lead*	X	X
Zinc*	X	X

The preliminary COPC metals listed above have been detected above the Residential Soil RSLs and have formerly been associated with mining-related activities in Cherokee County. However, all of the preliminary COPC metals are elements that are present in the earth's crust and, therefore, are naturally present in air, soil, and groundwater. Discussion of metals concentrations relative to typical background concentrations and screening values are presented in Section 5.1. The physical and chemical characteristics of these metals, along with typical industrial uses and general pathways into the environment, are discussed in detail in the following subsections.

6.1.1.1 Lead

Lead is a soft, dense, bluish-gray metal commonly found in the earth's crust. It typically does not occur alone in its elemental form, but combined with two or more other elements to form lead compounds such as the mineral galena. It has a low melting point and is very resistant to corrosion. The primary use for lead is in the manufacture of batteries. Other uses include piping, ammunition, radiation shielding, and historically as paint and gasoline additives. It is obtained primarily through mining and the recycling of batteries.

Lead is dispersed throughout the environment primarily as the result of anthropogenic activities, which include the mining and smelting of ore, manufacture of lead-containing products, combustion of coal and oil, and waste incineration. Many anthropogenic sources of lead, most notably leaded gasoline, lead-based paint, lead solder in food cans, lead-arsenate pesticides, and shot and sinkers, have been eliminated or strictly regulated due to lead's persistence and toxicity. Because lead does not degrade, these former uses leave their legacy as higher concentrations of lead in the environment.

Lead may enter the atmosphere as dust from mining/refining processes, and historically as particulates during the burning of leaded gasoline (banned in 1995). It may be present in soil resulting from the settlement of contaminated dust or from the disposal of mine tailings. The solubility of lead compounds in water is a function of pH, hardness, salinity, and the presence of organic material. Lead will absorb to clay particles or form lead carbonate in environments with a pH above 6 (EPA, 1992a). It will be retained in the upper 2 to 5 centimeters of soil, especially soils with at least 5 percent organic matter or a pH of 5 or above (Alloway, 1990). Lead is highly resistant to degradation and is extremely persistent in water and soil. It is not common to bioaccumulate in plants or animals.

Leaching is not likely under normal conditions as lead binds tightly to soil particles; however, acidic conditions may increase the likelihood of it leaching to water. It is expected to slowly undergo speciation to the more insoluble sulfate, sulfide, oxide, and phosphate salts. The most stable form of lead in natural water is a function of the ions present, the pH, and the reduction-oxidation (redox) potential. In oxidizing systems, the least soluble common forms are probably the carbonate, hydroxide, and hydroxycarbonate. Because it is strongly adsorbed to soil, it generally is retained in the upper layers of soil and does not tend to leach appreciably into the subsoil and groundwater (ATSDR, 2007). Lead is effectively removed from the water column to sediment by adsorption to organic matter and clay minerals, precipitation as insoluble salt, and reaction with hydrous iron and manganese oxide (ATSDR, 2007). Under most circumstances, adsorption predominates.

6.1.1.2 Cadmium

Cadmium is a soft, bluish-white metal common in the Earth's crust. It is not often present in its elemental form, but is extracted as a byproduct during the mining and processing of other ores and metals such as copper, lead, and zinc. It is primarily used in the production of rechargeable nickel-cadmium batteries, and to a lesser extent in the manufacture of solar panels, paint pigments, and in electroplating processes.

Cadmium is present in the environment in both its elemental and combined (oxide) forms. The main anthropogenic sources of cadmium to the environment include nonferrous metal mining and refining, manufacture and application of phosphate fertilizers (containing up to 300 mg/kg), fossil fuel combustion, and waste incineration and disposal. Natural emissions of cadmium to the environment can result from volcanic eruptions, forest fires, generation of sea salt aerosols, or other natural phenomena.

Cadmium can travel long distances in the atmosphere resulting in elevated cadmium levels even in remote locations. It is known to bioaccumulate in aquatic organisms and agricultural crops (ATSDR, 2008).

The chemistry of cadmium in soil and water is primarily controlled by pH, so that under acidic conditions solubility increases and adsorption decreases, and vice versa under alkaline soil conditions. Clay minerals, carbonates, or oxides of iron and manganese may facilitate the absorption of cadmium, or may lead to its precipitation as cadmium carbonate, hydroxide, or phosphate (EPA, 1992a). Generally, cadmium will bind strongly to organic matter making it immobile (ATSDR, 2008). It is likely to occur as a hydrated ion when present in its dissolved state. It may form cadmium sulfide under reducing conditions, which is poorly soluble and immobile. Sorption and precipitation to soil particles, metal oxides, and organic matter are the primary means of entrainment (ATSDR, 2008).

6.1.1.3 Zinc

Zinc is the 24th most abundant element found in the Earth's crust and is found in the air, soil, and water. In its pure elemental form, zinc is a bluish-white shiny metal. Metallic zinc has many uses in industry, the most common being as a corrosion resistant coating for iron and other metals in a process called galvanization. Metallic zinc also is mixed with other metals to form alloys such as brass and bronze. Zinc compounds are widely used in industry for preserving wood and in manufacturing and dyeing fabrics. They are also used by the drug industry as ingredients in some common products such as sunblock, deodorants, acne and poison ivy preparations, and antidandruff shampoos.

Zinc enters the air, water, and soil as a result of both natural processes and human activities. The primary sources of zinc in the environment are related to mining and metallurgic operations involving zinc and use of commercial products containing zinc. The most important sources of zinc in soil come from discharges of smelter slags and wastes, mine tailings, coal and bottom fly ash, and the use of commercial products such as fertilizers and wood preservatives that contain zinc (ATSDR, 2005). Most of the zinc in soil or sediment is bound to the soil particle and does not dissolve in water. However, some zinc may leach to groundwater when present in acidic conditions. The level of zinc in soil increases mainly from disposal of zinc wastes from metal manufacturing industries and coal ash from electric utilities. Zinc can be discharged into waterways through waste streams from metal manufacturing, chemical industries, domestic wastewater, and run-off from soil containing zinc.

Zinc is readily absorbed by clay minerals, hydrous oxides, and carbonates (EPA, 1992a). Most of the zinc in bodies of water binds to sediment and settles on the bottom. However, a small amount may remain either dissolved in water or as fine suspended particles. The level of dissolved zinc in water may increase as the acidity of water increases. Some fish can collect zinc in their bodies if they live in water containing zinc, and it may be taken up by animals eating soil or drinking water containing zinc. It has a moderate bioaccumulation rate in aquatic organisms, but does not accumulate in plants and does not magnify in the food chain (ATSDR, 2005).

6.2 OVERVIEW OF FATE AND TRANSPORT PROCESSES

The focus of this RI, and primary migration and exposure pathway, is soil exposure because of the known widespread lead contamination in chat-dominated surface soils and subsurface soils of the rail beds.

Discussion of the sediment and surface water exposure pathways is limited to Section 7.2 as part of the ERA. The sediment and surface water data was obtained from sampling conducted for a separate site. The groundwater exposure pathway was not included in the Statement of Work (SOW) for this RI.

6.2.1 Contaminant Transport

This section discusses the physical and chemical processes affecting the transport of the COPC metals in the environment. The primary transport mechanism for metals contamination in OU8 was the use of mining chat as ballast on the rail beds. Secondary transportation of contamination to and from the rail beds would be from leaching into native soil underlying the chat, airborne dust, and surface water runoff. The dust and runoff could originate from the now contaminated rail beds onto the surrounding area, or to the area of the rail beds from mine wastes situated nearby the former rail lines.

The mobility of most metals is inversely related to how tightly bound they are to soil or organic particles. The inherent nature of most metals is to bind to soil particles, particularly very fine-grained soils or those with high organic contents, either electrostatically (cation exchange) or chemically (specific adsorption) (EPA, 1992a). Important factors which influence the extent to which a metal will adsorb include: the presence of soluble metal complexes, the competition between a metal ion of interest and other species for the same adsorption sites, redox potential, and pH. This greatly reduces their mobility in the environment. Volatilization from the soil is a minor pathway, even for potentially volatile metals such as arsenic, mercury, and selenium (EPA, 1992a). This process is not expected to play a major role in metals fate and transport at this site.

Although metals are inclined to become immobile in the environment by binding to soil particles, they still have the potential to move through the environment if the soil or organic particles to which they are bound are moved through erosion. Weathering of the chat, or its transportation to the rail bed, can create fine particulate material with the potential for airborne deposition (wind-blown and settlement by gravity) or wet deposition (settled out of the atmosphere via precipitation). Nearby mine waste piles of tailings and processed ore leave materials exposed to wind and precipitation, which again allows transport of contaminants in dust particles and in suspension in surface water drainage from these areas.

6.2.2 Contaminant Fate

As a general rule, their elemental nature means that metals cannot be destroyed or degraded in the environment, but they can change forms or become attached to or separated from particles. This occurs through precipitation or ligand exchange reactions. The typical fate of anthropogenic metals in the environment is to be bound to near-surface soil particles.

6.2.2.1 <u>Degradation</u>

Contaminants in the environment can be degraded by abiotic (physical) and biotic (biological) processes. Hydrolysis and photolysis are typical abiotic processes. Biotic processes rely on microorganisms to degrade contaminants. These processes have a greater effect on organic compounds compared to inorganic compounds such as metals. Due to their elemental nature, most metals are highly resistant to degradation.

Hydrolysis is the chemical reaction between water (or hydroxide ion) and a contaminant molecule. The rate of hydrolysis is strongly influenced by the temperature and pH of the system. Metals typically do not hydrolyze because they are generally insoluble and, therefore, this process is not expected to play a major role in degradation of contaminants at this site.

The degradation of chemicals due to interactions from light energy is referred to as photolysis. Direct photolysis is a key process in systems with little particulate matter, whereas indirect photolysis predominates in more turbid systems (Chapra, 1997). These transformation processes can occur in surface soil, surface water, and the atmosphere. Photolysis is not expected to play a major role in degradation of metals at this site because these metals are known for their natural corrosion resistant properties.

Bacteria can degrade a wide range of organic contaminants under aerobic conditions and anaerobic conditions. Direct degradation occurs when the microbes receive metabolic benefit from the degradation process through use of the contaminant as an electron donor or an electron acceptor. Indirect degradation occurs when the enzymes produced by the microbe to metabolize one compound are also effective on a second compound, but the microbe derives no metabolic benefit from the reaction. For biodegradation to occur, the contaminant must be dissolved in water; however, the majority of metals are insoluble in water. In addition, contaminants that are sorbed to soil or sediment are not available for biodegradation. Thus, contaminants with high organic partitioning values, such as metals, can be resistant to microbial activity. While some biodegradation of metals does occur, the rates in the environment are generally low, allowing these elements to persist.

6.2.2.2 Transformation

Transformation refers to a change in valence state for metals. Some microbes can transform metals. For example, iron-reducing bacteria use ferric iron as an electron acceptor, and thereby reduce ferric iron to the ferrous form. The valence state of a metal can also be affected by abiotic reactions. Because of the effect of valence state on metal sorption and dissolution, transformation processes can be important in systems with metals contamination.

6.2.2.3 Bioaccumulation

Site contaminants can accumulate in the tissues of plants and animals. This process is water-based in that the contaminant must be in the aqueous phase in order to be available for uptake within the organism's tissue. Metals bioavailability in soils is influenced by soil pH and organic matter content. The bioavailability of organic compounds and metals is affected by their tendency to sorb to soil particles and its organic matter content. Bioaccumulation is not identified as a complete pathway for contaminants on this project because the metals are insoluble in water and because the level of metals uptake is comparatively low to the concentration of the same metals in the soil.

6.3 CONCEPTUAL SITE MODEL

Development of the CSM is a key step in assessing the potential remedies that may be suitable for a site contaminated with organic or inorganic (metals) compounds. Characterization of the nature of the release and migration mechanisms, the extent of contamination, as well as an exposure pathway analysis, are required to determine the level of risk posed by the contaminant release and to select and to design an appropriate remedy. The physical and chemical characteristics of the COPCs are also taken into account when developing the CSM.

Based on historical background information and analytical results from previous field efforts, initial data considered in developing the CSM includes:

- Chat from mining activities conducted in Cherokee County from 1850 to 1970 was used as ballast on rail road beds in the county;
- Selected metals contamination was detected in the surface and subsurface soil fill material (chat) used as ballast for the rail beds;
- Native soil also was contaminated with metals to a depth of 48-inches bgs, likely due to leaching of metals from the overlying weathered chat ballast;
- Surface soils on and near the rail beds also may have been impacted by surface water runoff and airborne dust from mine wastes lying adjacent to the abandoned rail lines in some area, or from the same migration mechanisms acting on the rail beds themselves; and

- The three COPCs (cadmium, lead, and zinc) were detected above their respective Residential Soil RSLs.

Figure 6.1 presents the CSM developed for the site, and includes a visual depiction of the pathway for mining-related wastes to enter the environment. The conceptual exposure models for human health and ecological risk developed to identify potentially exposed populations by tracking contaminant movement in the environment from the source to receptor are discussed in Section 7.

6.4 SUMMARY

Analytical data from the RI and previous investigations indicate that COPC metals are present in the chat supplied as rail road ballast that is associated with historical mining activities in Cherokee County. These metals have been detected above their Residential Soil RSLs in the surface and subsurface soils of the rail beds that are predominantly weathered chat, and also in the underlying native soils. It is evident that the elevated concentrations of metals are derived from the chat and other mining wastes. This is supported by analytical data indicating that elevated metals concentrations generally decreased significantly in samples of native soils versus the overlying weathered chat.

The near-surface soils present in Cherokee County (Section 2.3) include many silts and clays, which also underlie the weathered chat. Organic materials in the silts and the fine-grained nature of the clays make it likely that metals weathering and leaching from the chat would bind tightly to the soil particles and become immobile in the environment. As discussed above, the preliminary COPC metals have a tendency to adsorb to soils and their mobility is highly limited, especially in the case of fine-grained soils and/or soils with high content of organic matter. Soils and sediments can become sinks for heavy metals. Metals generally have low water solubility, resulting in limited ability to dissolve in surface water or groundwater under ambient conditions. They also tend to partition out of the aqueous phase onto organic matter or fine-grained soil particles. These properties combined with their natural corrosion resistance lead to their being immobile and persistent in the environment. Sorption and precipitation to soil particles, metal oxides, and organic matter are the primary means of entrainment of metals contamination in the environment.

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7.0 BASELINE RISK ASSESSMENT

This section summarizes the approach and results of the HHRA and ERA prepared by EPA and presents the conclusions supported by the results. In addition to the surface and subsurface soil samples collected by HGL, EPA collected surface water and sediment samples at the site to support the ERA. The analytical results of these additional matrices were included in the dataset used by EPA risk assessors and are discussed in relation to the ERA.

7.1 HUMAN HEALTH RISK ASSESSMENT SUMMARY

This section summarizes the approach and results of the risk assessment completed for the CCR OU8 site and presents the conclusions supported by these results. The complete HHRA is provided in Appendix J. Figure 3.1 of the HHRA (Appendix J) illustrates the conceptual site model for human exposure.

7.1.1 SUMMARY OF HHRA APPROACH

An HHRA was conducted for the site consistent with current EPA guidelines for HHRA at Superfund sites (USEPA 1989; 1991a; 1991b; 1992b; 2002a; 2002b; 2004; 2009a). Site characterization data collected during the RI was used in the HHRA to evaluate possible health risks for recreational visitors and hypothetical future construction/excavation workers within the study area. Assumptions, methods, and results are summarized below.

7.1.1.1 Potentially Exposed Populations

High- and low-frequency recreational visitors and hypothetical future workers were identified as potentially exposed receptors for the CCR site. Recreational visitors (child, adolescent, and adult) are those who may walk, hike, play, and/or trespass along the historic rail lines in the area and be exposed via direct contact to surface soils along the rail beds. The hypothetical future worker represents construction/excavation workers who may be exposed via direct contact to surface and subsurface soils along the rail beds.

7.1.1.2 Media of Concern and Exposure Pathways

The objective of the HHRA is to assess potential exposures to cadmium, lead, and zinc for identified site receptors that could result from direct contact with mine-related contaminants in surface soil along the rail lines. Cadmium, lead, and zinc were the only contaminants evaluated within the HHRA based on previous investigations at the Cherokee County Superfund Site in which these metals were identified as the primary COCs (Dames & Moore, 1993; Newfields 2002). The exposure pathways evaluated in the HHRA include: incidental ingestion of surface soil, dermal contact with surface soil, and inhalation of airborne soil particles.

7.1.1.3 Data Used within the HHRA

Soil data used in the HHRA was generated from soil samples taken in May, June, and December of 2013, and September 2014. The September 2014 samples were collected by EPA in support of the HHRA. The collection and analysis of these samples are discussed further in Section 3.3. Soil samples were analyzed using XRF and a subset of these samples were also submitted to the laboratory for confirmatory analysis using inductively coupled plasma (ICP) methodology.

As discussed in Section 2.7 of Appendix J, lateral soil samples were collected at the site to evaluate the nature and extent of contamination. Average concentrations of lead and zinc were roughly 1- to 3-fold higher along the main rail line than at lateral sampling locations that radiate outward from the main lines. Accordingly, lateral samples were excluded from the HHRA in order to best represent potential contamination and to avoid potentially diluting the dataset used to calculate exposure point concentrations (EPCs).

The following criteria were used to determine which soil sample results were used in the HHRA dataset.

- If both XRF and ICP data were available for a sample, then only the ICP data were used.
- If only XRF data were available at a location, then the XRF results for lead and zinc were used (after they were adjusted to ICP-equivalent concentrations).
- For those samples that had both a parent sample and a duplicate result, the higher of the two values was used.
- Data for samples collected from lateral locations were not used to quantify risks in the HHRA.

7.1.1.4 Chemicals of Potential Concern

As discussed, the site COPCs of cadmium, lead, and zinc were identified in previous investigations for other OUs (Dames & Moore, 1993; Newfields, 2002).

7.1.1.5 Evaluation of Lead

Risks from lead are evaluated using a somewhat different approach than for most other chemicals. EPA recommends the use of toxicokinetic models to correlate blood lead concentrations with exposure and adverse health effects. Specifically, EPA recommends the use of the Integrated Exposure Uptake Biokinetic (IEUBK) model for children and the Adult Lead Methodology (ALM) for adults. The IEUBK Model for Lead in Children, Windows® version (EPA, 2010) was used to evaluate the potential for unacceptable health effects from lead exposures in soil to a future hypothetical child receptor. The IEUBK model is capable of evaluating lead exposures to young children up to age 7 years and considers children's exposure to lead in soil and other media, including water, air, and diet. Young children (less than 7 years old) are more susceptible to the toxic effects of lead, and generally receive the highest exposures to lead in soil and dust as a result of hand-to-mouth or object-to-mouth behaviors. Thus, protection of young children will also protect adult receptors in the same environment.

Blood lead levels for adolescent and adult recreational visitors and the hypothetical future construction worker are calculated using the ALM. The ALM (version date June 21, 2009) (EPA, 2009) is based on the premise that maternal blood lead levels are predictive of the potential for adverse health effects. The most sensitive target currently identified is the nervous system in a fetus or young child. The ALM predicts the blood lead levels (BLLs) in the fetuses of pregnant women from nonresidential exposure to lead-contaminated soil and dust (for example, a hypothetical future construction/excavation worker scenario). The ALM incorporates population-based background BLLs as a starting concentration and predicts BLLs that will likely result after additional exposure to lead-contaminated soil occurs. The ALM employs nonresidential exposure scenario to evaluate the potential for adverse health effects to a fetus carried by a female worker (EPA, 2009).

7.1.1.6 Evaluation of Non-Lead Metals

Cancer and non-cancer risks to recreational visitors and hypothetical future workers were assessed for non-lead metals under both the reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios. EPA guidance generally defines RME as the maximum exposure that could reasonably be expected to occur for a given exposure pathway at the site. The RME includes a combination of conservative average and upper-bound estimates of exposure parameters to estimate potential risks and hazards. The CTE uses typical or average parameter values to derive exposure estimates. The exposure parameters and assumptions used within the RME and CTE are presented in Tables 4.1, 4.2, and 4.3 of Appendix J. The Human Intake Factor and Time-Weighting Factor values are summarized in Table 4.4 of Appendix J.

7.1.2 SUMMARY OF HHRA RESULTS

Quantitative risk and hazard estimates were developed for recreational visitors and hypothetical future workers for the Site. The HHRA results are detailed in Appendix J and summarized below.

7.1.2.1 Lead

The IEUBK model was used to assess lead exposures for high-frequency and low-frequency child recreational visitors to the CCR site. The probabilities of a high- and low-frequency recreational child exposed to lead in soil having a BBL that exceeds micrograms per deciliter (10 µg/dL) are below the EPA's health-based goal of 5 percent. The probability of the BLL exceeding 10 µg/dL is referred to as the P10 value. The P10 values for the high-frequency and low-frequency child recreational visitors were 0.29 and 0.01 percent, respectively.

As detailed in Section 5.5 of Appendix J, estimated P10 values (using the ALM) were below the EPA health-based guideline (P10 ≤ 5 percent) for high-frequency and low-frequency recreational visitors and the hypothetical future worker. No risk is indicated for these receptors exposed to lead in site soil.

Since the establishment of the EPA's health protection goal, the Centers for Disease Control and Prevention (CDC) has identified 5 µg/dL as a "reference value" for blood lead in children (CDC, 2012). This concentration corresponds to the 97.5th percentile of BBLs in children in the United States. EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) is in the process of evaluating the CDC recommendations and implications for Superfund risk assessments, in close coordination and consultation with the CDC and the Agency for Toxic Substances and Disease Registry (ATSDR). Until that reassessment is complete, EPA is continuing to use a P10 value of 5 percent as the health-based goal to assess risk from exposure to lead at Superfund sites.

7.1.2.2 Non-Lead COPCs

Cancer and non-cancer risk values calculated for identified receptors exposed to site COPCs are summarized below. A full description of the non-lead COPC evaluation is presented in Section 4.4 of Appendix J.

7.1.2.2.1 Recreational Visitor

As detailed in Section 4.4 of Appendix J, non-cancer hazard indexes (HIs) and cancer risks quantified for the RME and CTE child, adolescent, and adult recreational visitors did not exceed target levels (HI <1 and cancer risk <1E-06) for both the high-frequency use and low-frequency use scenarios.

7.1.2.2.2 Construction Worker

As detailed in Section 4.4 of Appendix J, non-cancer HIs and cancer risks quantified for the RME and CTE hypothetical adult future construction worker did not exceed target levels.

7.1.3 CONCLUSIONS

Based on the results of the HHRA, human health risks for the recreational visitor (child, adolescent, and adult) and hypothetical future worker were below non-cancer HIs of 1, and cancer risks were within the EPA's target risk range of 1E-06 to 1E-04 for non-lead metals.

For lead, using the IEUBK model and ALM, P10 values were below the EPA's health based guideline (P10 ≤ 5 percent) for all receptors.

7.2 ECOLOGICAL RISK ASSESSMENT SUMMARY

This section summarizes the approach and results of the ERA completed for the site and presents the conclusions supported by these results. The complete ERA is provided in Appendix K. Figure 3 in Appendix D of the ERA illustrates the conceptual ecological exposure model.

7.2.1 Problem Formulation

The ERA for CCR OU8 was conducted in accordance with EPA's *Ecological Risk Assessment Guidance for Superfund* (EPA, 1992c), supplemented with more recent guidance and policy as appropriate. Site characterization data collected during the RI completed by HGL, and samples collected from additional matrices by EPA were used in the ERA to evaluate possible health risks for wildlife within the study area. Assumptions, methods, and results are summarized below.

7.2.1.1 Potentially Exposed Populations

During the years the mines operated, railroads were constructed in Cherokee County to join conventional large-scale railroads to the individual mining operations. Historically, the ballast used in the railroad beds was composed of chat from surrounding mine waste piles. Metals present in the chat could potentially migrate into the underlying soil. Additional migration pathways include soil to surface water/sediment, air to soil, and bioaccumulation. The potentially exposed ecological populations include benthic organisms, fish, terrestrial plants, soil organisms, and wildlife receptors (birds and mammals).

7.2.1.2 Media of Concern and Exposure Pathways

In terms of ecological receptors, the media of concern consist of potentially contaminated surface soil, surface water, and sediment. Exposure can occur through direct contact with these media. For birds and mammals, exposure pathways also include ingestion of surface water, incidental ingestion of soil and sediment, and consumption of food (e.g., plants, invertebrates, fish, mammals) with contaminants accumulated in the tissue. Although animals can inhale soil contaminants in dust, the inhalation pathway contributes negligibly as compared to the ingestion exposure route and thus is not typically evaluated. Fur and feathers minimize the potential for dermal absorption of contaminants.

7.2.1.3 Chemicals of Potential Concern

Based on results of other studies and assessments for sites within the study area, cadmium, lead, and zinc have been identified as the primary ecological COPCs and risk drivers.

7.2.1.4 Streamlined Risk Characterization

Because cleanup levels have already been developed for Cherokee County, a streamlined approach was used to characterize ecological risk in which EPCs were compared directly to cleanup levels. The ecological cleanup levels for soil were established in the ROD for Cherokee County (OU3 and OU4) (EPA, 2006). The cleanup levels for sediment are based on the values established for the Tri-State Mining District (MacDonald et al., 2010). Finally, surface water cleanup levels are based on chronic National Ambient Water Quality Criteria, and are adjusted based on site-specific hardness. The cleanup levels for each media are presented in Appendix K. The cleanup levels are meant to represent concentrations above which animals may exhibit impaired health from exposure to metals.

Based on the assessment endpoints selected for the development of the Cherokee County cleanup levels, each of the 34 rail bed locations and nine stream locations were considered separate exposure areas within the ERA.

7.2.2 SUMMARY OF ERA RESULTS

This section provides a more detailed discussion of the results from the comparison of detected concentrations to cleanup levels established for the Site. The ERA results are discussed below.

Surface Soil

For ecological risk assessment purposes, soil is generally collected at the 0 to 12 inch depth interval. Therefore, at all locations, results from the 0 to 6 inch and 6 to 12 inch depth intervals were combined and used to estimate potential risk to terrestrial receptors.

Zinc and cadmium contamination at concentrations exceeding cleanup levels is widespread on the rail lines. Cadmium concentrations are elevated above cleanup levels at every location evaluated. Zinc concentrations are elevated at every location, except for Location 20. Lead contamination on the rail lines is slightly less widespread, with eight locations not exceeding the soil cleanup level.

Surface Water

Lead concentrations were less than surface water cleanup levels at all 9 sample locations. Lead in surface water does not pose a threat to ecological receptors.

Zinc concentrations in surface water exceeded the cleanup levels (the National Ambient Water Quality Criteria) at two locations, SW02 and SW03. SW02 is within the city of Baxter Springs, just downstream from rail line locations 32 and 33. Extremely high concentrations of zinc were found at these rail line locations, suggesting the contamination in Willow Creek may be due to the rail line. However, the closest sample location to SW03 is Location 20, which was the only rail line location that did not exceed terrestrial cleanup levels for both zinc and lead (cadmium was not evaluated at this location), suggesting that the surface water contamination at SW03 does not appear to be attributable to the rail line.

Cadmium exceeded the cleanup level at SW04. SW04 is located in the headwaters of Tar Creek, where the stream is ephemeral. The hardness at SW04 is quite low compared to the rest of the locations. This low hardness value reduced the criteria value for cadmium, resulting in SW04 exceeding cleanup levels even though the cadmium concentration is only slightly above detection limits.

Sediment

Sediment concentrations of cadmium and zinc exceeded cleanup levels at one location, SD03. This particular location is adjacent to the Spring River within the city of Baxter Springs. The closest rail line sample is Location 20. As stated, Location 20 was the only rail line location that did not exceed terrestrial cleanup levels for both zinc and lead (cadmium was not evaluated at this location), suggesting that the sediment contamination at SD03 does not appear to be attributable to the rail line.

7.2.3 CONCLUSIONS

The ERA results indicate that site-related contaminants in surface soil, surface water, and sediment may pose a threat to ecological receptors:

- Surface soil concentrations exceeded cleanup values for cadmium at all sample locations, zinc at all locations but one, and lead at all but eight locations evaluated.
- Surface water contamination was identified at sample locations SW02 (zinc) and SW03 (zinc), and SW04 (cadmium). Based on nearby soil sample results, contamination at SW02 appears to be attributable to the rail line. Zinc contamination at SW03 and cadmium contamination at SW04 does not appear to be attributable to the rail line.
- Sediment concentrations of cadmium and zinc exceed cleanup levels at one location, SD03. Based on nearby soil sample results, sediment contamination at SD03 does not appear to be attributable to the rail line.

The ERA produced by EPA is provided in Appendix K.

8.0 SUMMARY AND CONCLUSIONS

RI activities at the CCR Site were conducted to help meet the overall objectives for the site, which are to determine the physical characteristics of the site; define the nature and extent of contamination; update and refine the CSM; assess actual and potential exposure pathways through affected media; supply EPA risk assessors with data to support the HHRA and ERA; and evaluate potential remedial alternatives. As directed by EPA, this RI included only surface and subsurface soil sampling; the risk assessments were prepared by EPA. The HHRA evaluated surface soil exposure, and the ERA evaluated ecological risk associated with exposure to surface soil, sediment, and surface water. Other pathways are not discussed.

8.1 SUMMARY OF REMEDIAL INVESTIGATION ACTIVITIES

The RI data collection efforts were designed to fill gaps in the assessment of the rail lines in areas not previously investigated as part of other OUs to provide a comprehensive understanding of contaminant distribution along abandoned sections. RI activities are summarized in the following sections.

8.1.1 RI Scope of Work

HGL's scope of work for the RI for the Cherokee County OU8 Site included the following data collection and evaluation activities:

- Identify and map active and historical rail lines and their condition using a pre-determined classification system;
- Determine the nature and extent of cadmium, lead, and zinc contamination in soil on and adjacent to the rail beds (of the former rail lines) at the site that exceed established Federal or State limits, or in the event such limits have not been promulgated, that pose human health or ecological risks above acceptable limits.
- Update and refine the CSM to ensure site characterization is completed in sufficient detail to support decision making.
- Assess actual and potential exposure pathways through affected media.
- Supply the EPA risk assessors with the necessary data to prepare an HHRA and ERA.
- Prepare a comprehensive RI Report documenting the characterization work performed at the site to support the identification and evaluation of potential remedial options in the FS, with the ultimate goal of selecting an approach for site remediation in the ROD.

8.1.2 Remedial Investigation Activities

The RI activities evaluated the potential impact of the abandoned rail beds at the site. All samples were analyzed for lead, cadmium and zinc and submitted to the EPA Region 7 laboratory. Field activities for the CCR RI were conducted in three field events in 2013: May 8, 9, and 10; June 10, 11, and 12; and December 2, 3, and 4 and included:

- Obtained access from multiple property owners and BNSF Railroad across the site.
- Collected surface and subsurface soil samples at 34 locations from 102 test pits along abandoned rail lines within the site area.

- Excavated 102 test pits (parallel to and perpendicular to the rail lines) to a maximum depth of 48 inches and used an XRF unit to field screen soil samples collected from each 6-inch interval. Field screened a total of 101 surface and 486 subsurface soil samples for lead, cadmium and zinc.
- Collected and submitted 66 confirmation soil samples to the EPA Region 7 laboratory for fixed-lab analysis.

8.2 ANALYSIS OF REMEDIAL INVESTIGATION DATA

8.2.1 Screening and Confirmation Data Correlation

Three XRF readings and their respective uncertainty values were recorded, averaged, and documented for the metals cadmium, lead, and zinc at each interval. Uncertainty values were expressed as a +/- error value. The XRF calibration was confirmed with check standards at the beginning of each day, and when the battery on the unit was changed.

Comparison of the lead screening data to the laboratory confirmation sample lead concentrations shows a correlation of 0.821. The correlation value was obtained by performing a regression analysis on the datasets. According to EPA Method 6200 employed for the XRF analysis, a correlation of at least 0.7 is considered to be acceptable screening level data.

8.2.2 Nature and Extent of Contamination

The metals contamination of the rail lines resulted from the use of chat for rail bed ballast. Based on the soil samples collected from the 102 test pits divided among the 34 sample locations, cadmium, lead, and zinc contamination is widespread within the rail beds both at the surface and in subsurface materials at levels exceeding Residential Soil RSLs. As expected, COPC concentrations were highest in the chat, which in some test pits extended to at least 48 inches. Metals concentrations in native soil below the chat were lower, but contaminant levels above Residential Soil RSLs were detected in several samples.

8.3 SUMMARY OF CONTAMINATE FATE AND TRANSPORT

Although most metals are expected to be chemically or physically bound to soil particles, these particulates have the potential to migrate through the environment through erosion or leaching from the weathered chat rail bed ballast into native soil. The CSM developed for the site depicts leaching from the chat into underlying native soil; airborne particulate deposition; and surface water runoff of suspended particulates. These transport mechanisms allow metals contamination to impact surface soil and subsurface soil.

8.4 SUMMARY OF RISK ASSESSMENT FINDINGS

The three COPCs identified for the site were evaluated in the risk assessments. Site characterization data collected during the RI and during additional field investigations conducted by EPA as part of the risk assessments, across the site were used in the HHRA to evaluate possible health risks for recreational visitors or hypothetical future construction/excavation worker in the areas surrounding the site. The HHRA report is provided in Appendix J and the ERA report in

Appendix K.

8.4.1 Summary of Human Health Risk Assessment

Based on the results of the HHRA, human health risks for the recreational visitor (child, adolescent, and adult) and hypothetical future worker were below non-cancer HIs of 1, and cancer risks were within the EPA's target risk range of 1E-06 to 1E-04 for non-lead metals.

For lead, using the IEUBK model and ALM, P10 values were below the EPA's health-based guideline (P10 $\leq$ 5 percent) for all receptors.

8.4.2 Summary of Ecological Risk Assessment

The ERA results indicate that cadmium, lead, and zinc in surface soil at the majority of sample locations poses a threat to ecological receptors. Zinc in surface water at one location (SW02) was determined to both pose a threat to ecological receptors and be attributable to the rail line. No potential risks to ecological receptors attributable to site-related contamination was identified for sediment.

8.5 CONCLUSIONS

The RI activities have gathered an adequate amount of usable data from samples collected historically and during this RI to determine the potential impact of metals contamination in the rail beds comprising the OU8 site to human and ecological receptors. During this RI, select surface and subsurface soil samples (both from weathered chat and native soil) were field screened for cadmium, lead, and zinc. Based on evaluation of the RI data gathered during the field activities, the following conclusions were drawn:

- Background levels in Cherokee County of the COPCs cadmium, lead, and zinc were below their Residential Soil RSLs.
- The COPCs were detected in surface and subsurface samples of the weathered chat used as ballast for the rail beds of the former rail lines.
    - Widespread cadmium, lead, and zinc contamination at concentrations above their respective Residential Soil RSLs is present in the OU8 rail beds.
    - Samples collected from native soil below the weathered chat in the rail beds also was contaminated with cadmium, lead, and zinc.
    - COPC concentrations in the native soil were significantly lower than those observed in the weathered chat.
    - It is evident that the metals contamination related to mining activities in Cherokee County has "migrated" to the OU8 rail beds and underlying native soil is some areas through the use of chat as railroad ballast.
- Based on the results of the HHRA, no significant human health risks are identified for either the recreational visitor (child, adolescent, and adult) or hypothetical future worker, as all calculated non-cancer HIs and cancer risks were below target levels.
- The ERA results indicate that site-related contaminants in surface soil, surface water, and sediment may pose a threat to ecological receptors:
    - Surface soil concentrations exceeded cleanup values for cadmium at all sample locations, zinc at all locations but one, and lead at all but eight locations evaluated.

- Surface water contamination was identified at sample locations SW02 (zinc) and SW03 (zinc), and SW04 (cadmium). Based on nearby soil sample results, contamination at SW02 appears to be attributable to the rail line. Zinc contamination at SW03 and cadmium contamination at SW04 does not appear to be attributable to the rail line.
- Sediment concentrations of cadmium and zinc exceed cleanup levels at one location, SD03. Based on nearby soil sample results, sediment contamination at SD03 does not appear to be attributable to the rail line.

The FS will be prepared in accordance with EPA guidance and will evaluate viable remedial alternatives and recommend an appropriate action to assure that potential risks to human health and the environment are appropriately managed. The FS will outline and recommend a remedial alternative for the site based on the data presented.

9.0 REFERENCES

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TABLE(S)

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Table 3.1
Confirmation Sample Summary Table
Remedial Investigation Report
Cherokee CountySite - OU8 Railroads, Cherokee County KS

Sample Location	EPA Lab ID	Sample Collection Date	Sample Depth (in bgs)	QC Samples Field Duplicate	Results		
					Cd	Pb	Zn
CCR-SS-1A	6105-36	12/2/2013	0-6		**42.6**	**490**	**9,870**
CCR-SS-1B	6105-37	12/2/2013	18-24		**43.4**	**266**	**9,920**
CCR-SS-1C	6105-38	12/2/2013	24-30		**52.8**	**475**	**13,300**
CCR-SS-2A	6105-39	12/2/2013	6-12		**84.6**	**1,940**	**16,200**
CCR-SS-3A	6105-11	5/9/2013	6-12		**29.2**	**417**	**4,500**
CCR-SS-3B	6105-14	5/9/2013	30-36		**1.7**	**61.5**	**393**
CCR-SS-4A	6105-12	5/9/2013	18-24		**27.0**	**193**	**5,780**
	6105-12-FD			X	**37.0**	**257**	**7,200**
CCR-SS-5A	6105-10	5/9/2013	12-18		**113**	**837**	**22,000**
CCR-SS-5B	6105-9	5/9/2013	6-12		**24.1**	**3,260**	**7,170**
CCR-SS-6A	6105-40	12/2/2013	6-12		**24.3**	**322**	**6,080**
CCR-SS-6B	6105-41	12/2/2013	18-24		**17.0**	**76.6**	**2,430**
CCR-SS-7A	6105-16	5/9/2013	12-18		**35.3**	**510**	**7,520**
	6105-16-FD			X	**30.1**	**361**	**6,430**
CCR-SS-7B	6105-15	5/9/2013	6-12		**40.3**	**270**	**9,610**
CCR-SS-8A	6105-8	5/8/2013	12-18		**67.2**	**266**	**15,200**
CCR-SS-8B	6105-7	5/8/2013	6-12		**79.3**	**906**	**16,800**
CCR-SO-9A	6105-3	5/8/2013	0-6		**48.2**	**369**	**11,900**
CCR-SS-9B	6105-2	5/8/2013	42-48		**0.63 J**	**24.6**	**97.1 J**
CCR-SS-9C	6105-1	5/8/2013	24-30		**37.0**	**225**	**8,910**
CCR-SO-10A	6105-6	5/8/2013	0-6		**38.6**	**395**	**8,190**
CCR-SS-10B	6105-5	5/8/2013	6-12		**41.5**	**338**	**9,860**
CCR-SS-10C	6105-4	5/8/2013	6-12		**37.7**	**152**	**8,680**
CCR-SS-11A	6105-73	12/5/2013	0-6		**38.8 J**	**827**	**12,600**
CCR-SS-12A	6105-71	12/5/2013	12-18		**9.7**	**300**	**3,600**
CCR-SS-12B	6105-72	12/5/2013	0-6		**45.1**	**457**	**12,000**
CCR-SS-13A	6105-74	12/5/2013	6-12		**46.5**	**820**	**9,420**
CCR-SS-13A	6105-20	5/10/2013	6-12		**7.4**	**149**	**1,210**
CCR-SS-13B	6105-69	12/5/2013	18-24		**45.9**	**1,640**	**8,470**
CCR-SS-13C	6105-68	12/4/2013	12-18		**59.1**	**1,390**	**11,400**
CCR-SS-13D	6105-70	12/5/2013	6-12		**41.7**	**3,750**	**4,100**
CCR-SS-13E	6105-66	12/4/2013	18-24		**4.4**	**329**	**722**
	6105-66-FD			X	**3.1**	**178**	**545**
CCR-SO-15A	6105-19	5/10/2013	0-6		**16.4**	**461**	**2,330**
CCR-SS-15B	6105-18	5/10/2013	6-12		**11.2**	**556**	**1,820**
CCR-SO-16A	6105-22	5/10/2013	0-6		**16.8**	**528**	**2,530**
CCR-SO-16B	6105-21	5/10/2013	0-6		**8.9 J**	**265**	**1,600**
CCR-SS-17A	6105-29	6/11/2013	12-18		**50.9**	**1,050**	**10,300**
CCR-SS-17B	6105-26	6/11/2013	18-24		**39.2**	**78.0**	**6,730**
CCR-SS-17C	6105-25	6/11/2013	12-18		**86.3**	**288**	**19,300**

Table 3.1 (Continued)
Confirmation Sample Summary Table
Remedial Investigation Report
Cherokee County Site - OU8 Railroads, Cherokee County KS

Sample Location	EPA Lab ID	Sample Collection Date	Sample Depth (in bgs)	QC Samples Field Duplicate	Results		
					Cd	Pb	Zn
CCR-SS-18A	6105-24	6/11/2013	24-30		**4.3**	**53.8**	**946**
CCR-SS-19A	6105-28	6/11/2013	36-42		1.5 U	**74.8**	**123**
CCR-SS-20A	6105-23	6/11/2013	36-42		**15.6**	**240**	**1290 J**
	6105-23-FD			X	**12.4**	**198**	**1,140**
CCR-SS-20B	6105-27	6/11/2013	12-18		**15.6**	**58.1**	**1,370**
CCR-SS-21A	6105-33	6/12/2013	24-30		**24.5**	**364**	**4,830**
CCR-SS-21B	6105-31	6/12/2013	12-18		**11.5**	**468**	**2,260**
CCR-SS-21C	6105-30	6/12/2013	6-12		**12.9**	**916**	**3,470**
	6105-30-FD			X	**13.7**	**981**	**3,770**
CCR-SS-22A	6105-32	6/12/2013	30-36		0.43 U	**7.3**	**13.9**
CCR-SS-22A	6105-35	6/12/2013	36-42		0.53 U	**22.7**	**67.5**
CCR-SS-23B	6105-34	6/12/2013	18-24		**43.9**	**123**	**7,680**
CCR-SS-24A	6105-43	12/3/2013	24-30		**2.1**	**86.0**	**383**
CCR-SS-24B	6105-42	12/3/2013	6-12		**36.5**	**609**	**6,640**
CCR-SS-25A	6105-45	12/3/2013	6-12		**49.2**	**1,960**	**14,100**
CCR-SS-25B	6105-44	12/3/2013	0-6		**37.9**	**386**	**8,090**
CCR-SS-26A	6105-47	12/3/2013	0-6		**37.2 J**	**884**	**8,100**
CCR-SS-26B	6105-46	12/3/2013	18-24		**33.4**	**472**	**8,450**
CCR-SS-27A	6105-49	12/3/2013	6-12		**54.5**	**4,260**	**12,100**
CCR-SS-27B	6105-48	12/3/2013	12-18		**55.2**	**429**	**10,500**
CCR-SS-28A	6105-51	12/3/2013	6-12		**69.8**	**466**	**12,500**
CCR-SS-28B	6105-50	12/3/2013	6-12		**29.5**	**392**	**5,770**
CCR-SS-29A	6105-55	12/4/2013	18-24		**62.6**	**380**	**11,400**
CCR-SS-29B	6105-52	12/3/2013	18-24		**48.6**	**403**	**10,700**
CCR-SS-30A	6105-53	12/4/2013	18-24		**100**	**2,310**	**17,700**
CCR-SS-30B	6105-54	12/4/2013	12-18		**10.2**	**1,500**	**2,040**
CCR-SS-31A	6105-57	12/4/2013	18-24		**55.4**	**3,600**	**13,700**
	6105-57-FD			X	**33.8**	**3,340**	**10,500**
CCR-SS-31B	6105-56	12/4/2013	12-18		**33.9**	**476**	**6,100**
CCR-SS-32A	6105-63	12/4/2013	18-24		**105**	**1,150**	**18,400**
	6105-63-FD			X	**55.5**	**1,320**	**12,300**
CCR-SS-32B	6105-65	12/4/2013	12-18		**107**	**1,260**	**21,700**
CCR-SS-33A	6105-59	12/4/2013	6-12		**60.0**	**727**	**11,600**
	6105-59-FD			X	**54.9**	**880**	**10,100**
CCR-SS-33B	6105-61	12/4/2013	6-12		**38.4**	**887**	**7,940**
	6105-61-FD			X	**42.6**	**737**	**7,280**

Notes:

Cd = cadmium
EPA = U.S. Environmental Protection Agency
in bgs = inches below ground surface
ID = identification
Pb = lead
QC = quality control
X = QC sample collected
Zn = zinc

Table 5.1
Background Soil Concentrations From 1993 RI
Remedial Investigation Report
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Sample ID	Sample Location	Pb	Cd	Zn
BBS-1	4063-SS-C3	8.9	0.6	9
BBS-2	4061-SS-LS	21	1.2	15
BBS-3	3611-SS-E2	14	0.7	170
BBS-4	1515 cell #1	14	0.7	48
BBS-5	1340 cell #1	23	0.7	41
TBS-1	1512 cell #1	29	1.2	21
TBS-2	1573 cell #1	16	0.6	16
TBS-3	1574 cell #1	13	1.2	31
Average		19	0.9	48.9
Residential Soil RSL		400	7.1	2,300

Notes:

The analytical results and RSLs are in milligrams per kilogram.

Cd = cadmium

ID = identification

Pb = lead

RSL = Regional Screening Level

Zn = zinc

Table 5.2
Cadmium Screening Data - Surface and Subsurface Soil Range of Detections
Remedial Investigation Report
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Depth Interval	Residential Soil RSL	Detection Range		Number of Detections	RSL Exceedances
		Minimum	Maximum		
0-6 inches	7.1	14	66	67	67
6-12 inches		14	74	62	62
12-18 inches		14	72	54	54
18-24 inches		14	74	47	47
24-30 inches		14	79	28	28
30-36 inches		18	36	25	25
36-42 inches		15	49	12	12
42-48 inches		13	37	10	10

Notes:
The analytical results and RSLs are in milligrams per kilogram.
EPA = U.S. Environmental Protection Agency
RSL = EPA Regional Screening Level for Residential Soil (June 2015)

Table 5.3
Lead Screening Data - Surface and Subsurface Soil Range of Detections
Remedial Investigation Report
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Depth Interval	Residential Soil RSL	Detection Range		Number of Detections	RSL Exceedances
		Minimum	Maximum		
0-6 inches	400	13	2,271	99	44
6-12 inches		14	2,255	80	43
12-18 inches		22	2,218	70	37
18-24 inches		17	3,490	65	32
24-30 inches		10	16,533	59	16
30-36 inches		11	7,739	55	15
36-42 inches		12	2,720	49	6
42-48 inches		7	2,013	41	3

Notes:
The analytical results and RSLs are in milligrams per kilogram.
EPA = U.S. Environmental Protection Agency
RSL = EPA Regional Screening Level for Residential Soil (June 2015)

Table 5.4
Zinc Screening Data - Surface and Subsurface Soil Range of Detections
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Depth Interval	Residential Soil RSL	Detection Range		Number of Detections	RSL Exceedances
		Minimum	Maximum		
0-6 inches	2,300	55	20,467	101	71
6-12 inches		71	23,967	81	62
12-18 inches		81	30,050	71	53
18-24 inches		29	19,433	68	45
24-30 inches		18	22,603	68	23
30-36 inches		27	19,100	68	20
36-42 inches		20	7,429	65	8
42-48 inches		18	7,720	61	5

Notes:

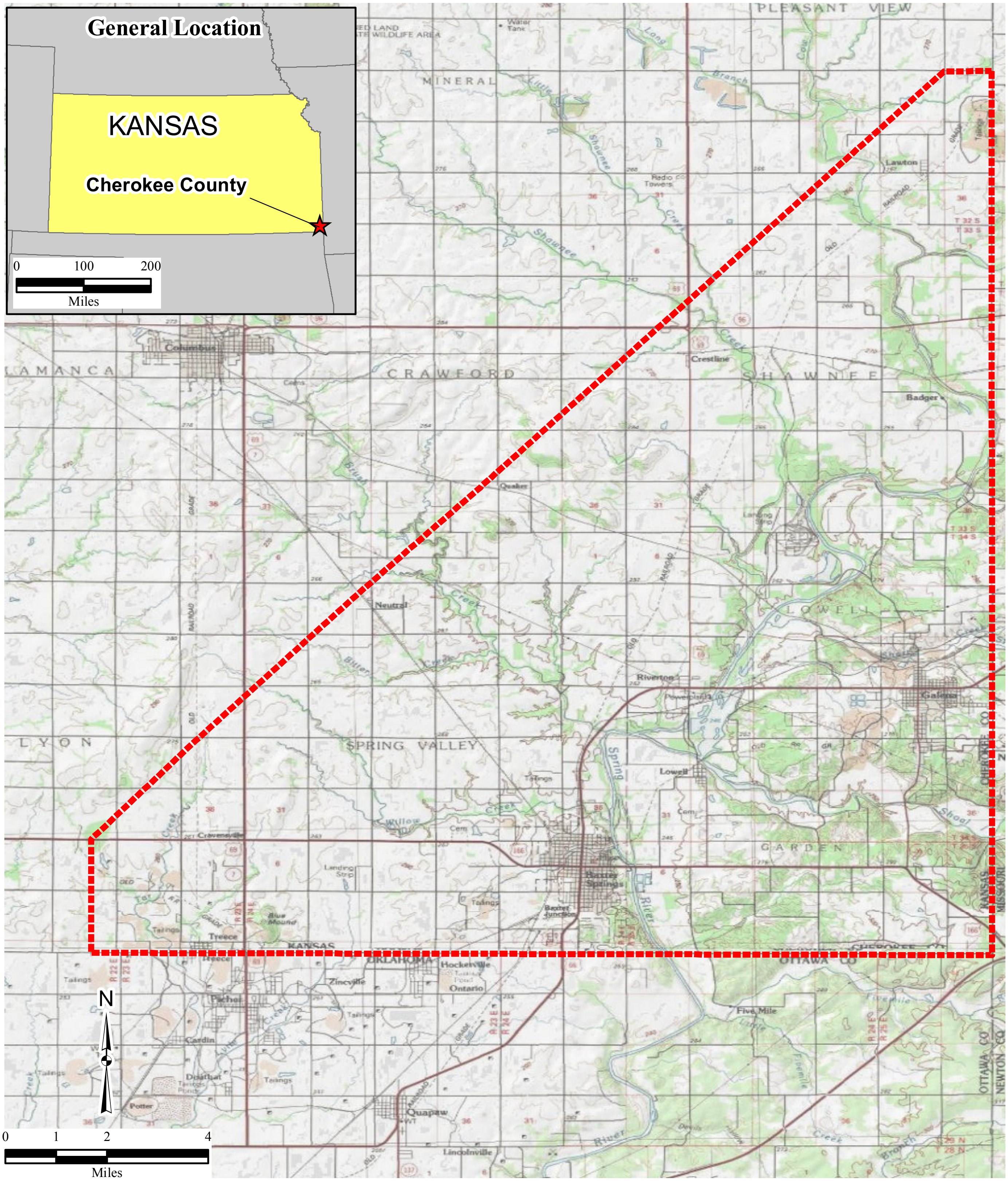
The analytical results and RSLs are in milligrams per kilogram.

EPA = U.S. Environmental Protection Agency

nsv = no screening value

RSL = EPA Regional Screening Level for Residential Soil (June 2015)

FIGURE(S)



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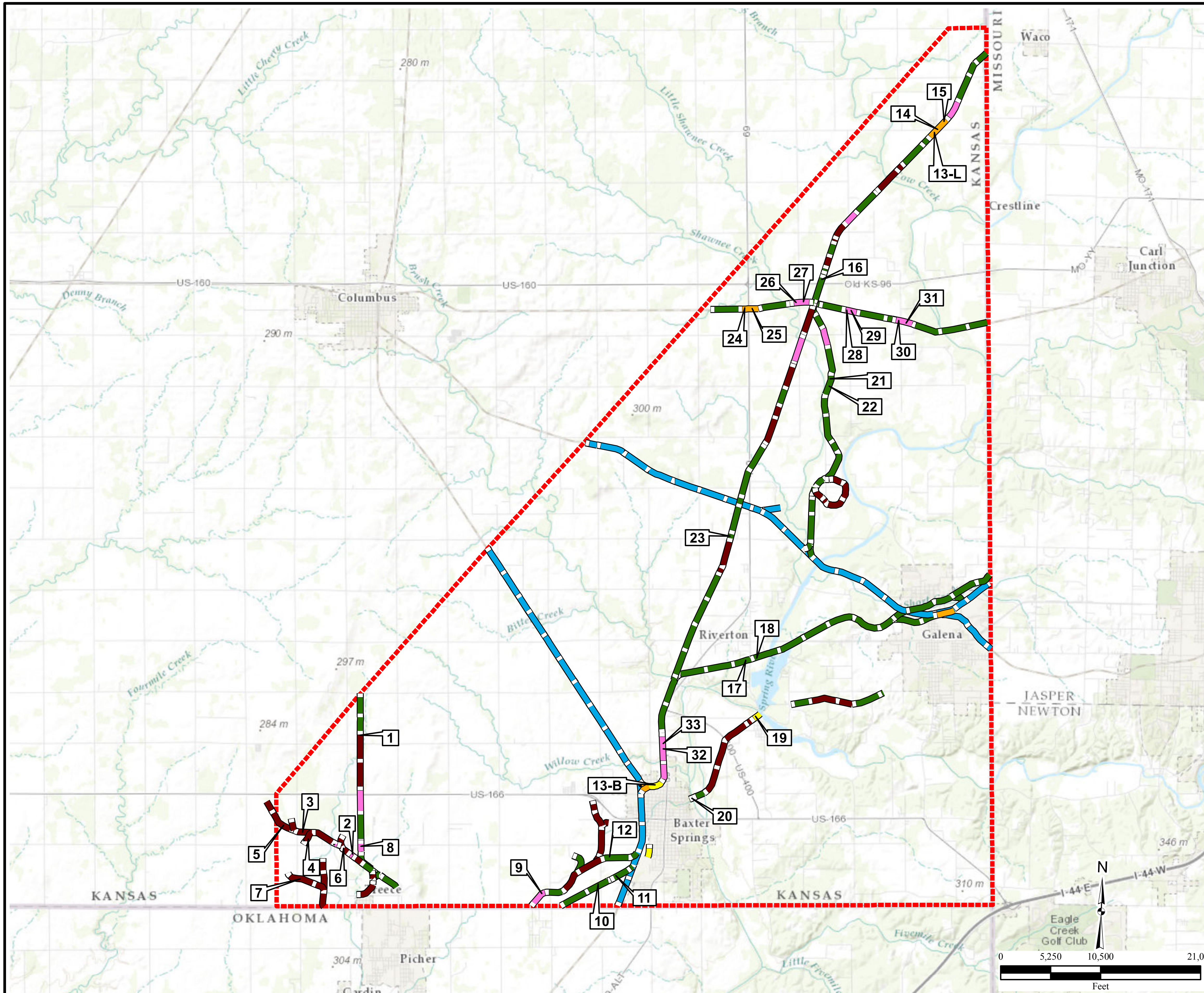
8/31/2015 JG
Source: HGL, ESRI Online USA Topo Maps

Legend

Site Boundary

HGL HydroGeoLogic, Inc

Figure 1.1
Site Vicinity Map



HGL—Remedial Investigation for Cherokee County Site-OU8 Railroads, Cherokee County, Kansas

Figure 3.1
Former Rail Line Classifications and Sample Locations

Legend

10 Sample Location

Site Boundary

Rail Classification

Active Line

Confirmed Class 1, Residential

Confirmed Class 1, Rural

Suspected Class 1, Rural

Suspected Class 2, Rural

Suspected Class 2, Residential

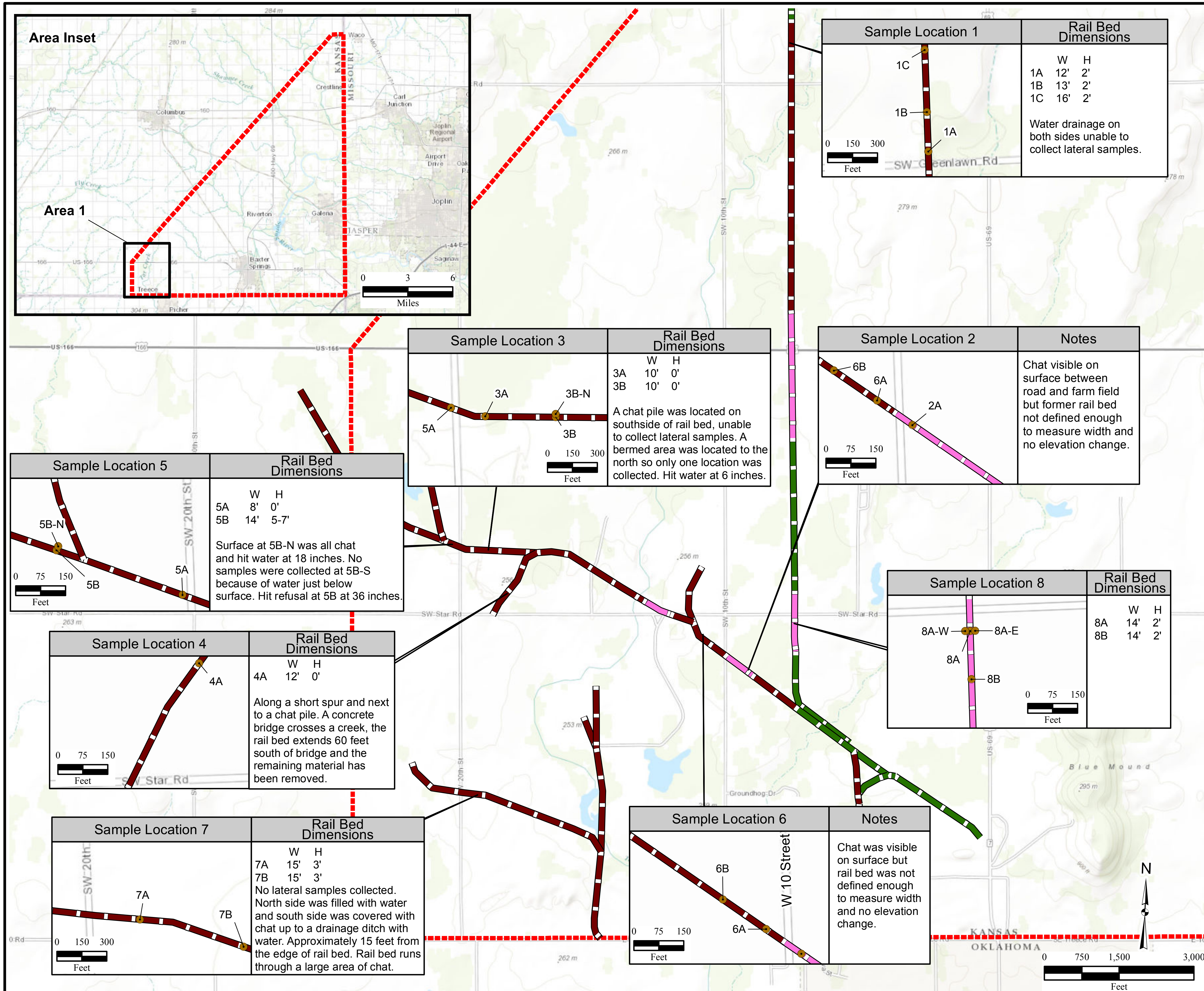
Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Confirmed=Visually inspected
Rural=land is agricultural or wooded with little or no exposure potential
Residential=land is in residential areas
Suspected=Based on surrounding visually inspected locations

\\Gst-srv-01\HGLGIS\Cherokee_County_MSIW\RI\ (3-01)RR_Class_Sample_Locs.mxd 8/31/2015 JG Source: HGL, ArcGIS Online USA Topo Map

HGL HydroGeoLogic, Inc.

HGL—Remedial Investigation for Cherokee County Site-OU8
Railroads, Cherokee County, Kansas

Figure 3.2
Area 1
Sample Locations



Legend

- Soil Sample
- Site Boundary

Rail Classification

- Confirmed Class 1, Rural
- Suspected Class 1, Rural
- Suspected Class 2, Rural

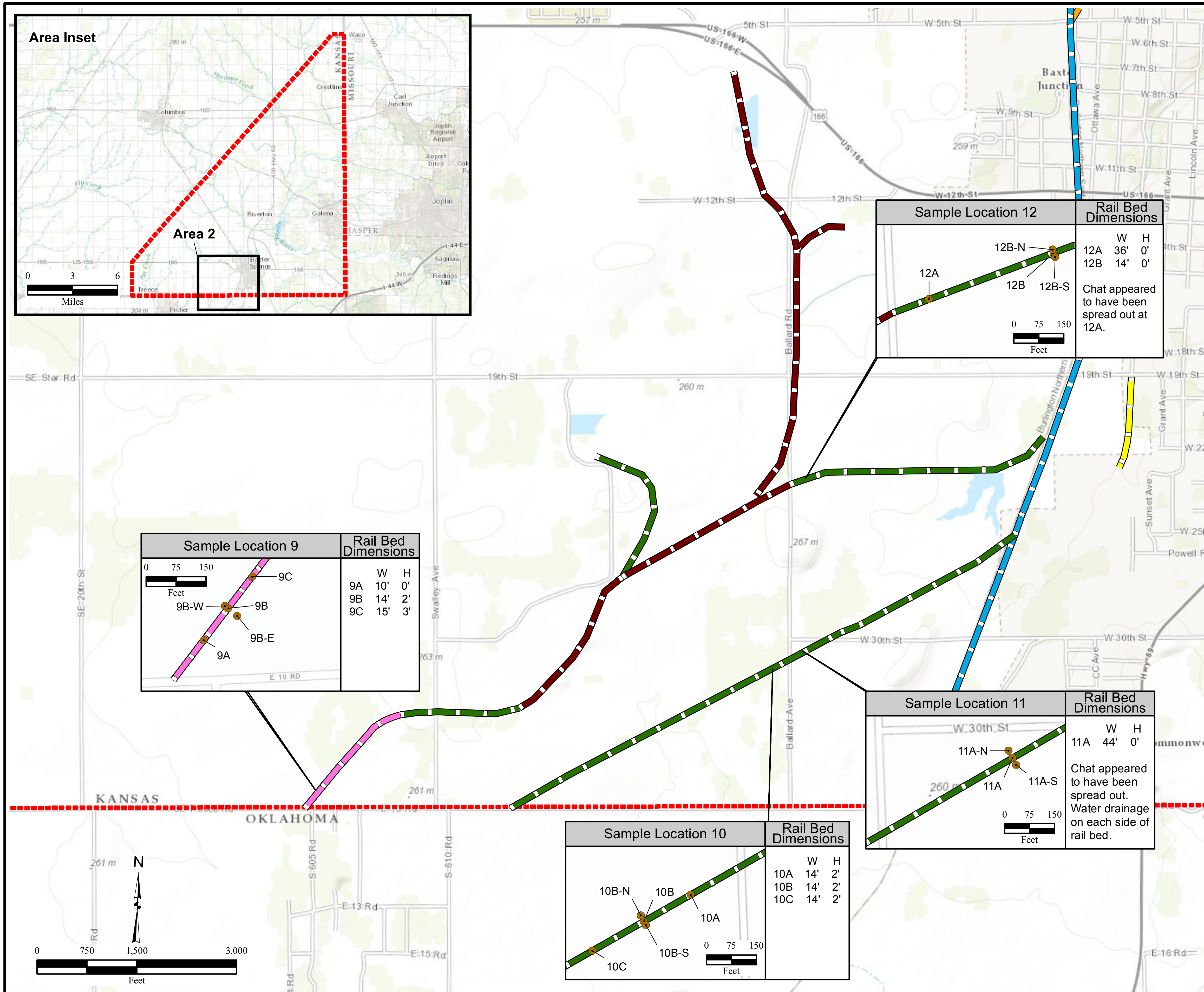
Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Confirmed=Visually inspected
H=height
Rural=land is agricultural or wooded with little or no exposure potential
Residential=land is in residential areas
Suspected=Based on surrounding visually inspected locations
W=width

\\Gst-srv-01\HGLGIS\Cherokee_County_MSIW\RI\ (3-02)Area_1_Locs.mxd
8/31/2015 JG
Source: HGL, ArcGIS Online USA Topo Map

HGL HydroGeoLogic, Inc.

HGL—Remedial Investigation for Cherokee County Site-OU8
Railroads, Cherokee County, Kansas

Figure 3.3
Area 2
Sample Locations



Legend

- Soil Sample
- Site Boundary

Rail Classification

- Active Line
- Confirmed Class 1, Residential
- Confirmed Class 1, Rural
- Suspected Class 1, Rural
- Suspected Class 2, Rural
- Suspected Class 2, Residential

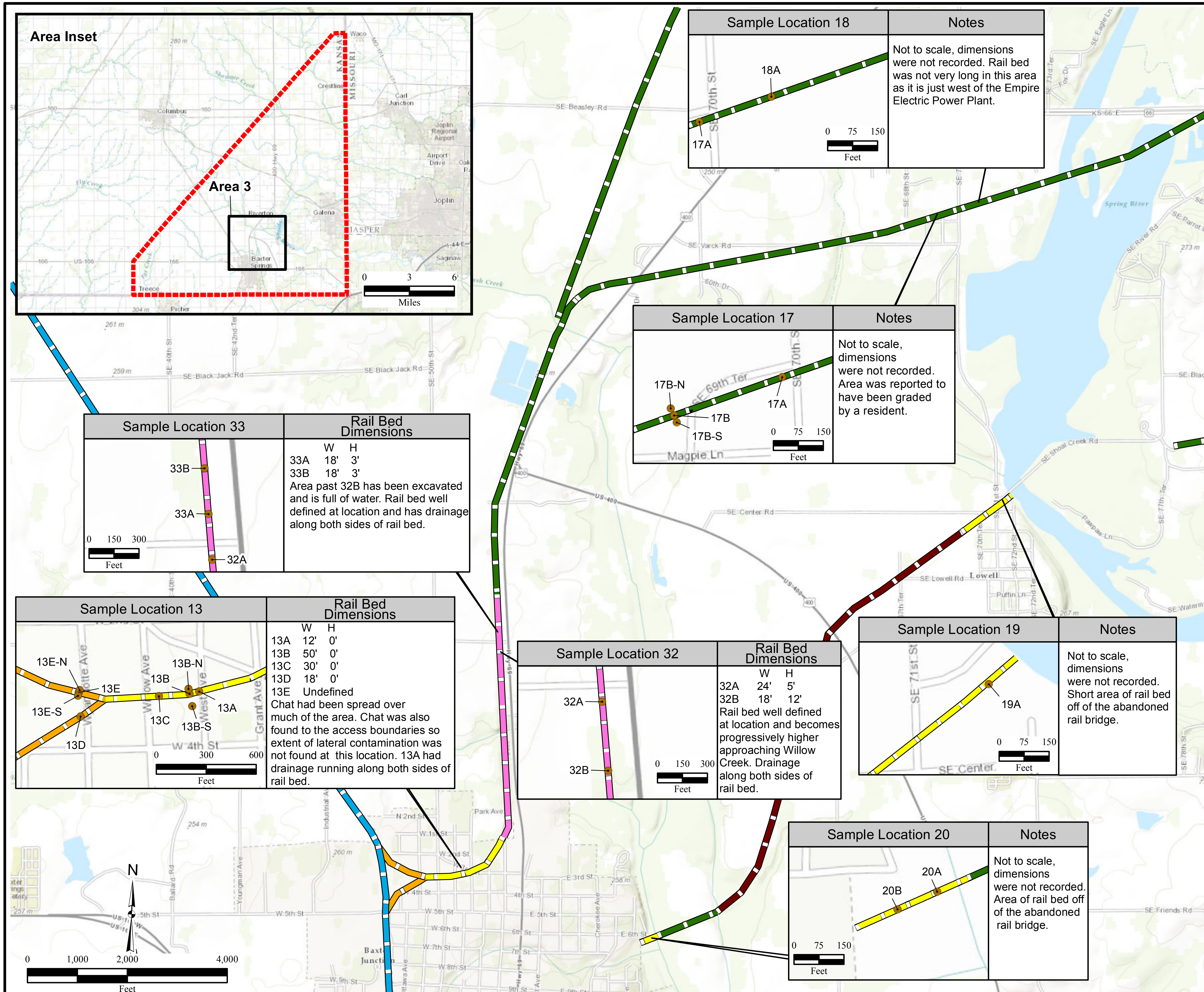
Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Confirmed=Visually inspected
H=height
Rural=land is agricultural or wooded with little or no exposure potential
Residential=land is in residential areas
Suspected=Based on surrounding visually inspected locations
W=width

\\Gst-srv-01\HGLGIS\Cherokee_County_MSIW\RI\ (3-03)Area_2_Locs.mxd
8/31/2015 JG
Source: HGL, ArcGIS Online USA Topo Map

HGL HydroGeoLogic, Inc

HGL—Remedial Investigation for Cherokee County Site-OU8
Railroads, Cherokee County, Kansas

Figure 3.4
Area 3
Sample Locations



Legend

Soil Sample

Site Boundary

Rail Classification

- Active Line
- Confirmed Class 1, Residential
- Confirmed Class 1, Rural
- Suspected Class 1, Rural
- Suspected Class 2, Rural
- Suspected Class 2, Residential

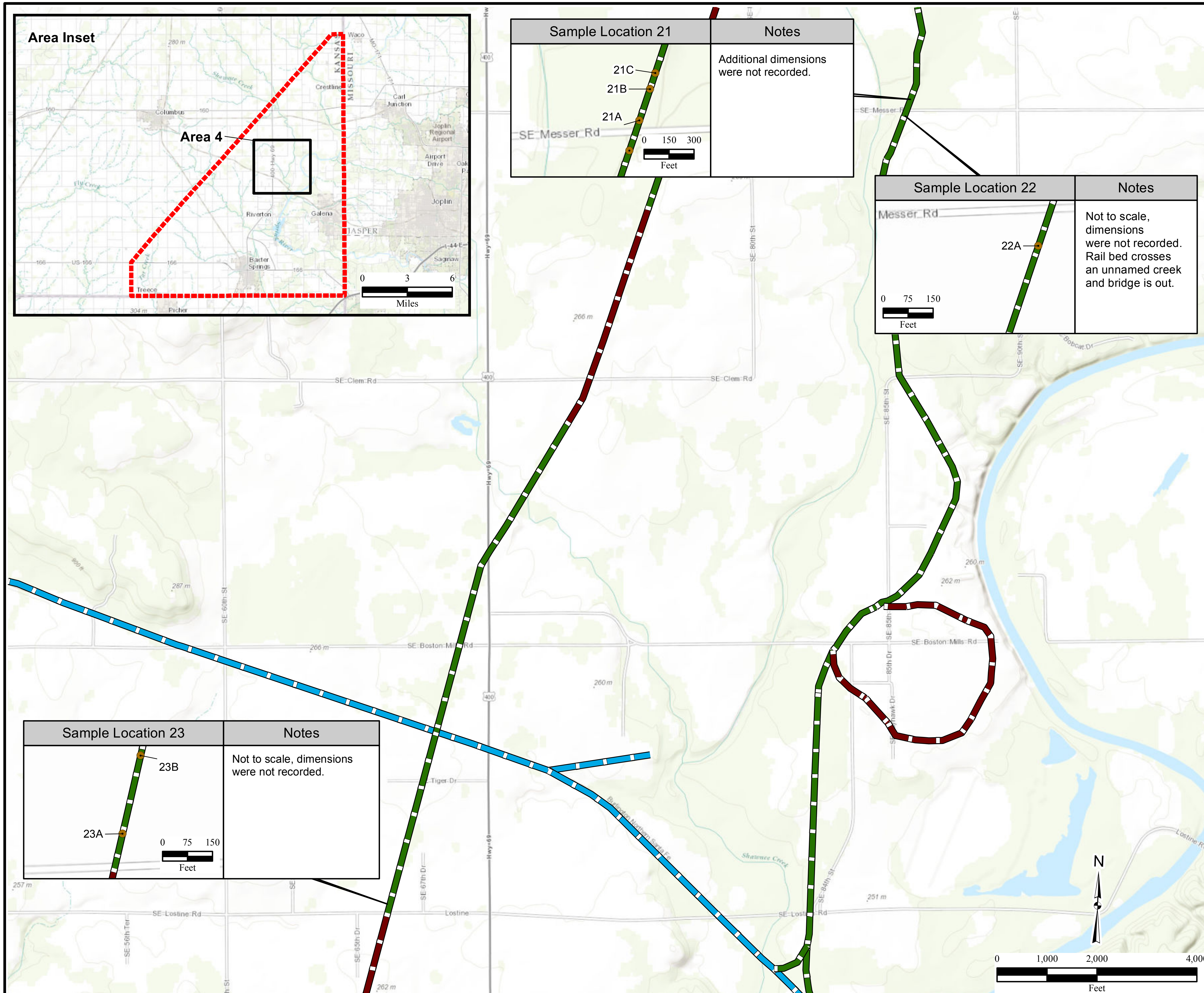
Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Confirmed=Visually inspected
H=height
Rural=land is agricultural or wooded with little or no exposure potential
Residential=land is in residential areas
Suspected=Based on surrounding visually inspected locations
W=width

\\Gst-srv-01\HGLGIS\Cherokee_County_MSIW\RI
(3-04)Area_3_Locs.mxd
8/31/2015 JG
Source: HGL, ArcGIS Online USA Topo Map

HGL HydroGeoLogic, Inc.

HGL—Remedial Investigation for Cherokee County Site-OU8 Railroads, Cherokee County, Kansas

Figure 3.5
Area 4
Sample Locations



Legend

Soil Sample

Site Boundary

Rail Classification

Active Line

Suspected Class 1, Rural

Suspected Class 2, Rural

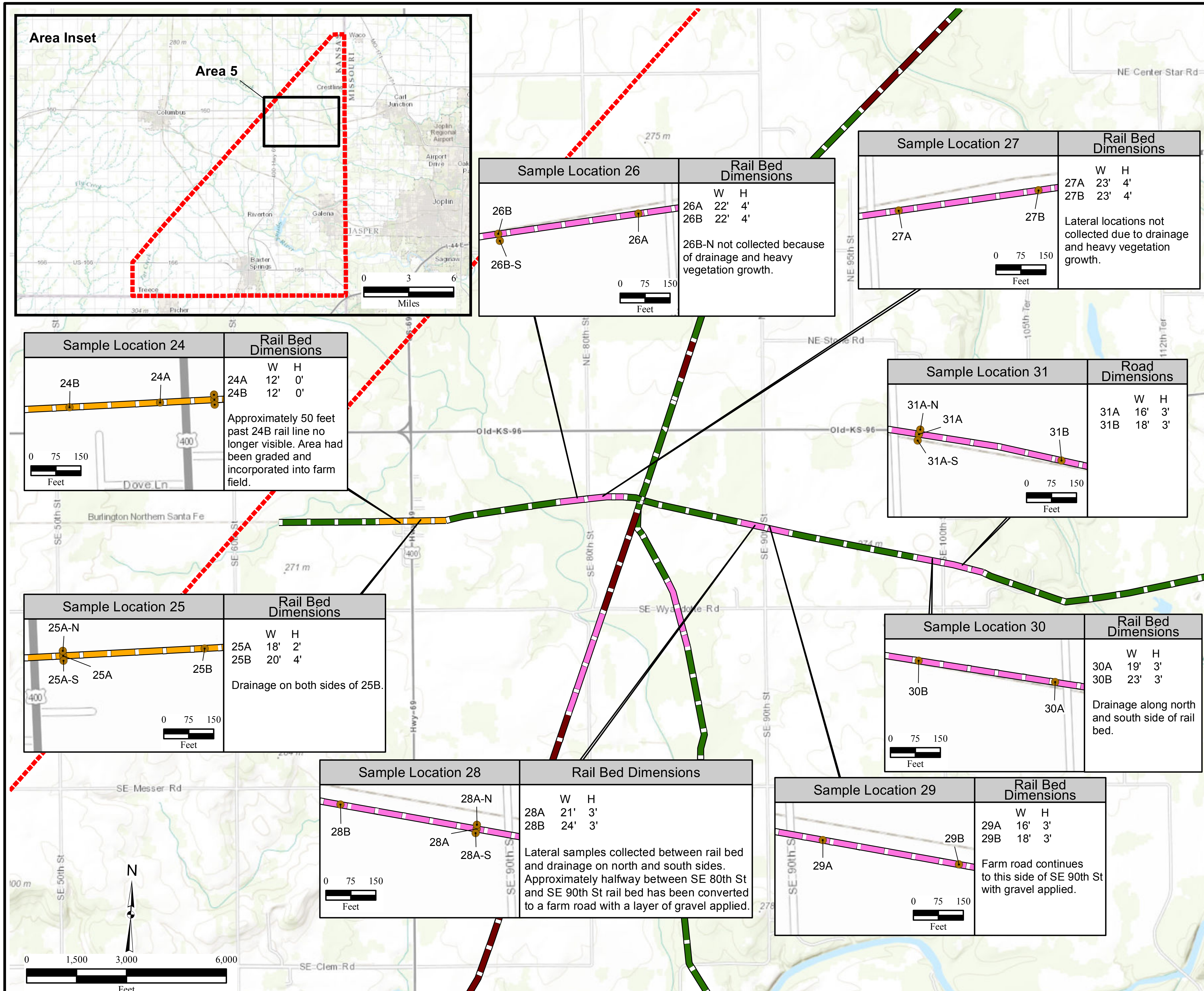
Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Confirmed=Visually inspected
H=height
Rural=land is agricultural or wooded with little or no exposure potential
Residential=land is in residential areas
Suspected=Based on surrounding visually inspected locations
W=width

\\Gst-srv-01\HGLGIS\Cherokee_County_MSIW\RI\ (3-05)Area_4_Locs.mxd
8/31/2015 JG
Source: HGL, ArcGIS Online USA Topo Map

HGL HydroGeoLogic, Inc.

HGL—Remedial Investigation for Cherokee County Site-OU8 Railroads, Cherokee County, Kansas

Figure 3.6
Area 5
Sample Locations



Legend

- Soil Sample
- Site Boundary

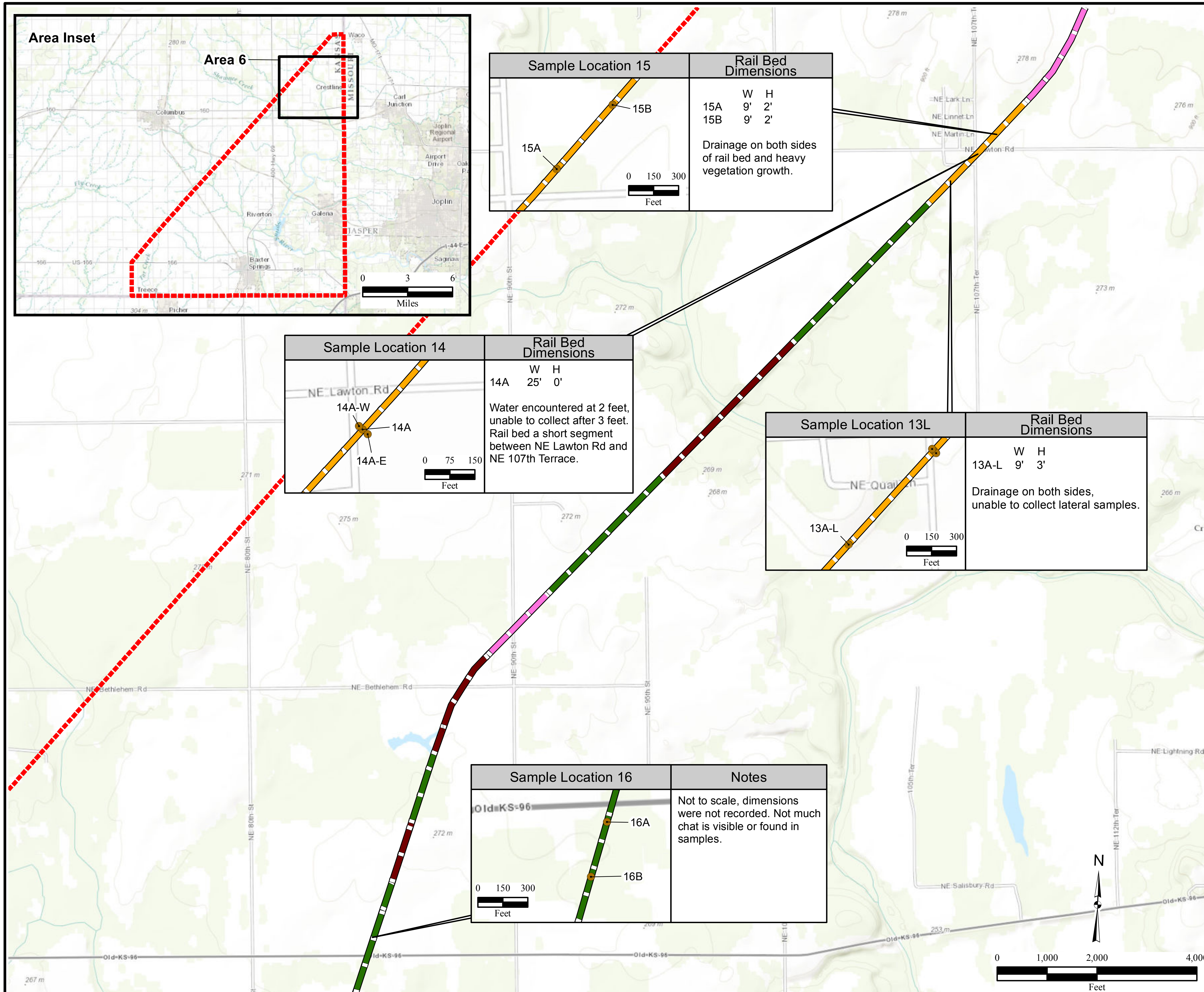
Rail Classification

- Confirmed Class 1, Residential
- Confirmed Class 1, Rural
- Suspected Class 1, Rural
- Suspected Class 2, Rural

Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Confirmed=Visually inspected
H=height
Rural=land is agricultural or wooded with little or no exposure potential
Residential=land is in residential areas
Suspected=Based on surrounding visually inspected locations
W=width

\\Gst-srv-01\HGLGIS\Cherokee_County_MSIW\RI\ (3-06)Area_5_Locs.mxd
8/31/2015 JG
Source: HGL, ArcGIS Online USA Topo Map

HGL HydroGeoLogic, Inc.



HGL—Remedial Investigation for Cherokee County Site-OU8 Railroads, Cherokee County, Kansas

Figure 3.7
Area 6
Sample Locations

Legend

Soil Sample

Site Boundary

Rail Classification

Confirmed Class 1, Residential

Confirmed Class 1, Rural

Suspected Class 1, Rural

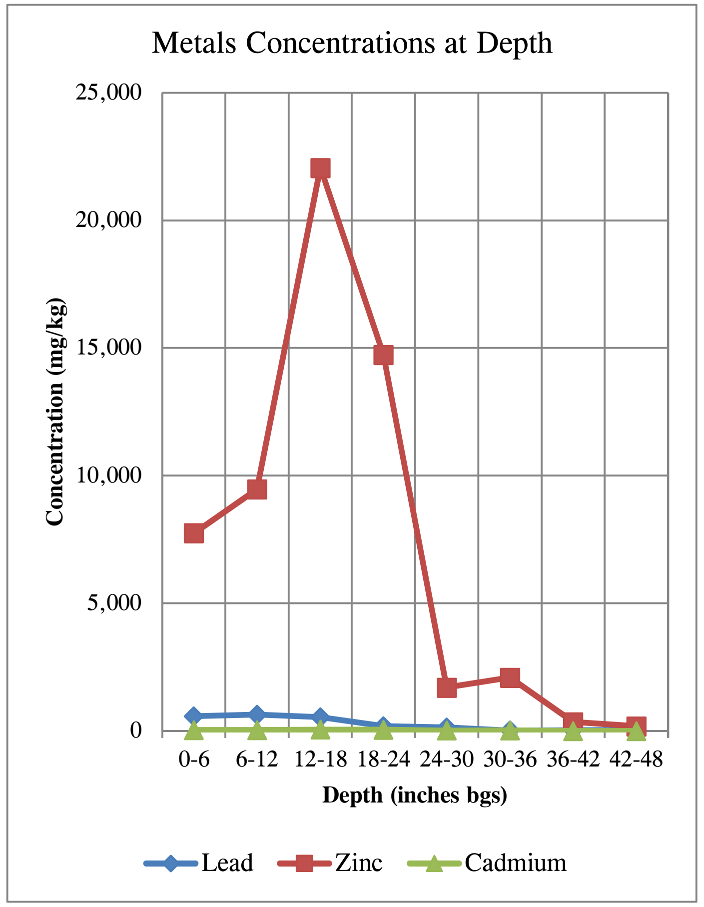
Suspected Class 2, Rural

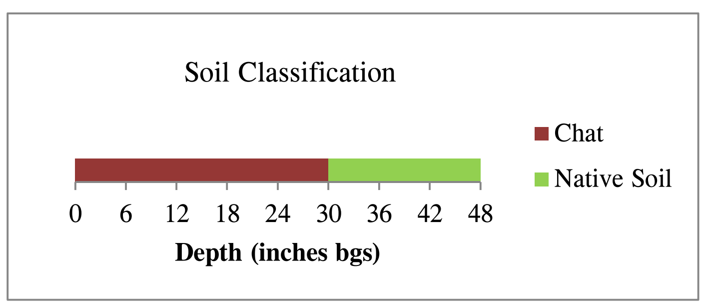
Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Confirmed=Visually inspected
H=height
Rural=land is agricultural or wooded with little or no exposure potential
Residential=land is in residential areas
Suspected=Based on surrounding visually inspected locations
W=width

\\Gst-srv-01\HGLGIS\Cherokee_County_MSIW\RI\ (3-07)Area_6_Locs.mxd
8/31/2015 JG
Source: HGL, ArcGIS Online USA Topo Map

Figure 5.1
Metals Concentrations at Depth - Location 1
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

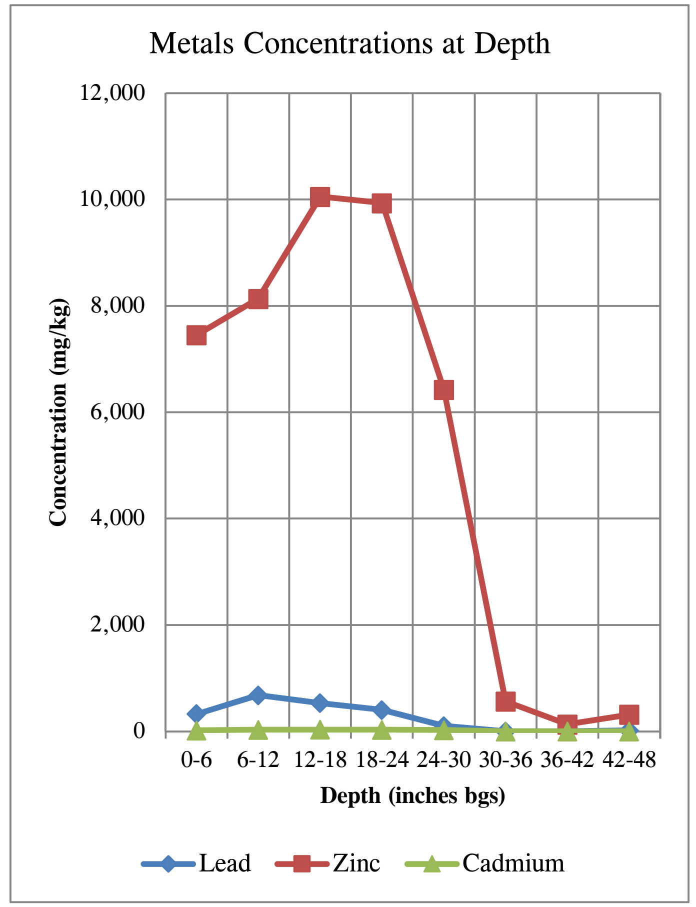
Test Pit 1A

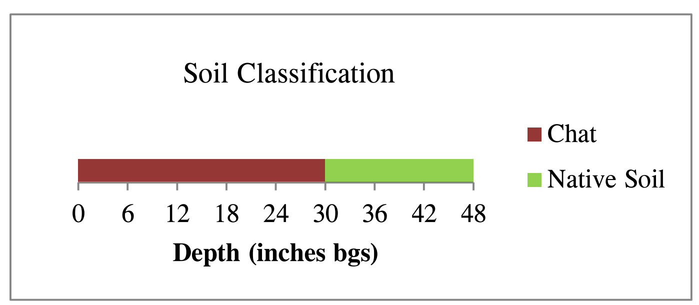




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**577**	**7,750**	**29**
6-12	**637**	**9,477**	**36**
12-18	**535**	**22,067**	**51**
18-24	**187**	**14,733**	**50**
24-30	**134**	**1,700**	**14**
30-36	**14**	**2,093**	**20**
36-42	**27**	**346**	< 12.4
42-48	**35**	**182**	< 12.6

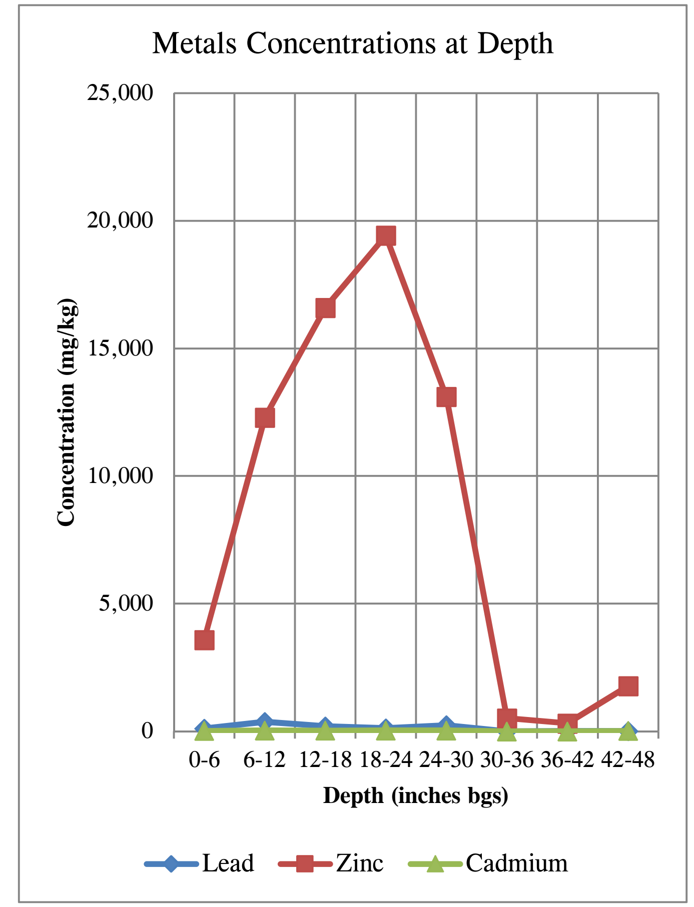
Test Pit 1B

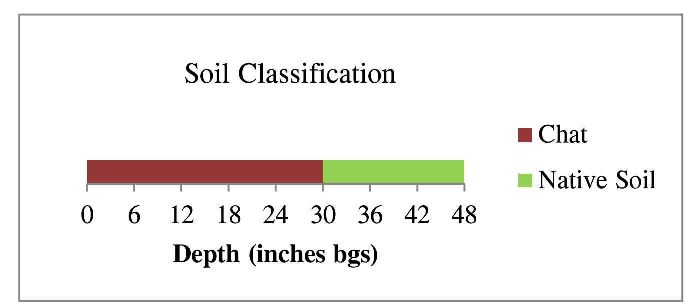




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**327**	**7,453**	**18**
6-12	**681**	**8,138**	**28**
12-18	**532**	**10,057**	**32**
18-24	**403**	**9,936**	**29**
24-30	**102**	**6,426**	**22**
30-36	< 11.1	**565**	< 13.1
36-42	< 9.2	**133**	< 12.2
42-48	**19**	**316**	< 13.0

Test Pit 1C





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**108**	**3,583**	**17**
6-12	**373**	**12,300**	**38**
12-18	**203**	**16,600**	**29**
18-24	**126**	**19,433**	**36**
24-30	**242**	**13,111**	**36**
30-36	< 11.8	**511**	< 13.7
36-42	**19**	**315**	< 14.5
42-48	**14**	**1,773**	**17**

Test Pit 1B-E

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**125**	**3,433**	**16**
6-12	**69**	**888**	< 11.8

Test Pit 1B-W

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**76**	**772**	< 12.8
6-12	**90**	**1,080**	< 13.0

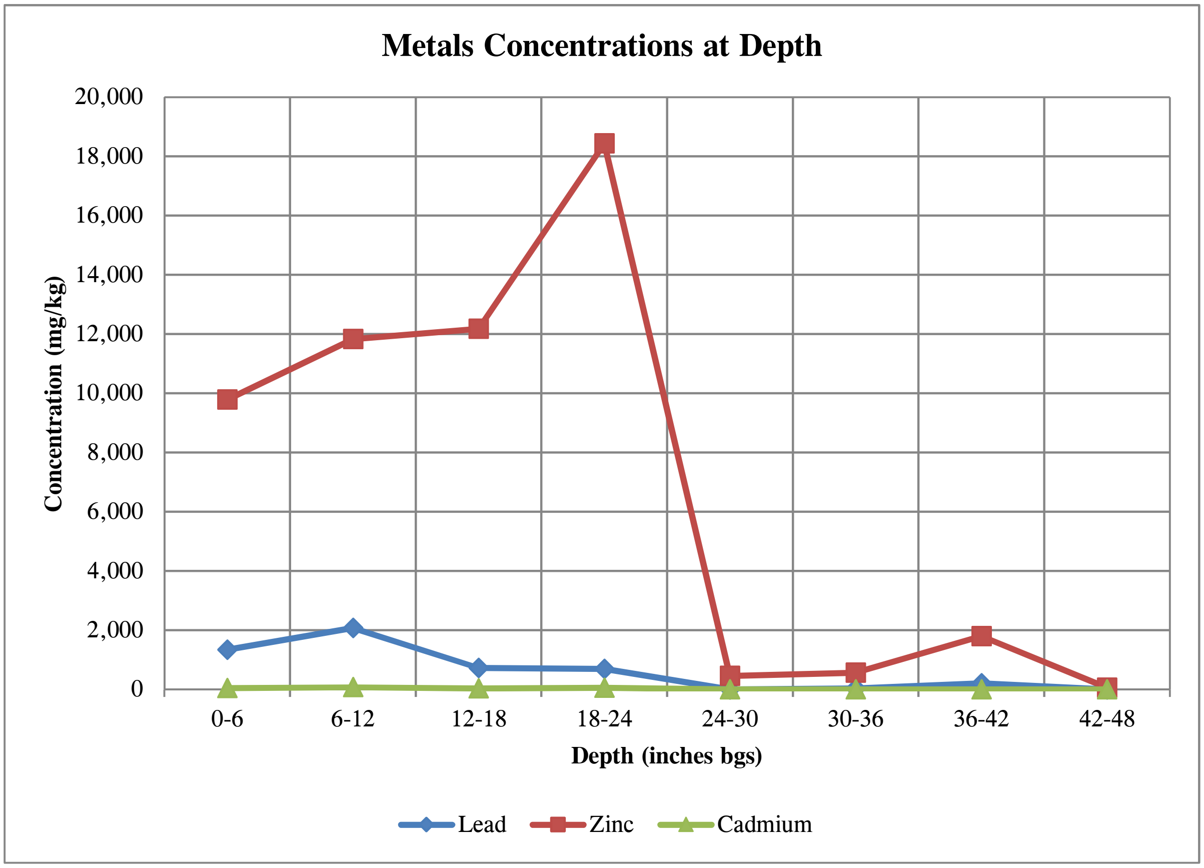
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

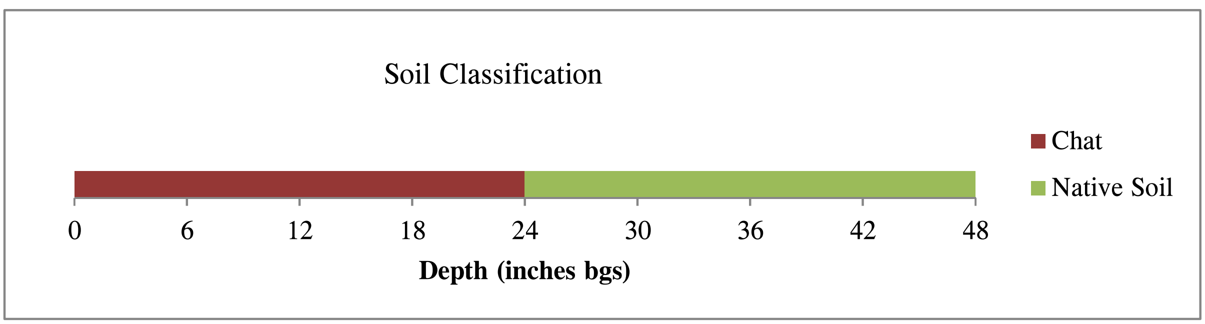
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.2
Metals Concentrations at Depth - Location 2
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas
Field Screening Data

Test Pit 2A





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**1,339**	**9,788**	**47**
6-12	**2,077**	**11,833**	**74**
12-18	**727**	**12,179**	**37**
18-24	**690**	**18,433**	**62**
24-30	<9.8	**461**	<15.7
30-36	**31**	**563**	<13.1
36-42	**208**	**1,799**	<15.1
42-48	<13.2	**60**	<15.2

- Above Residential RSL

bgs - below ground surface

mg/kg - milligrams per kilogram

Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Residential Soil Regional Screening Levels

Total Hazard Quotient = 0.1 (June 2015)

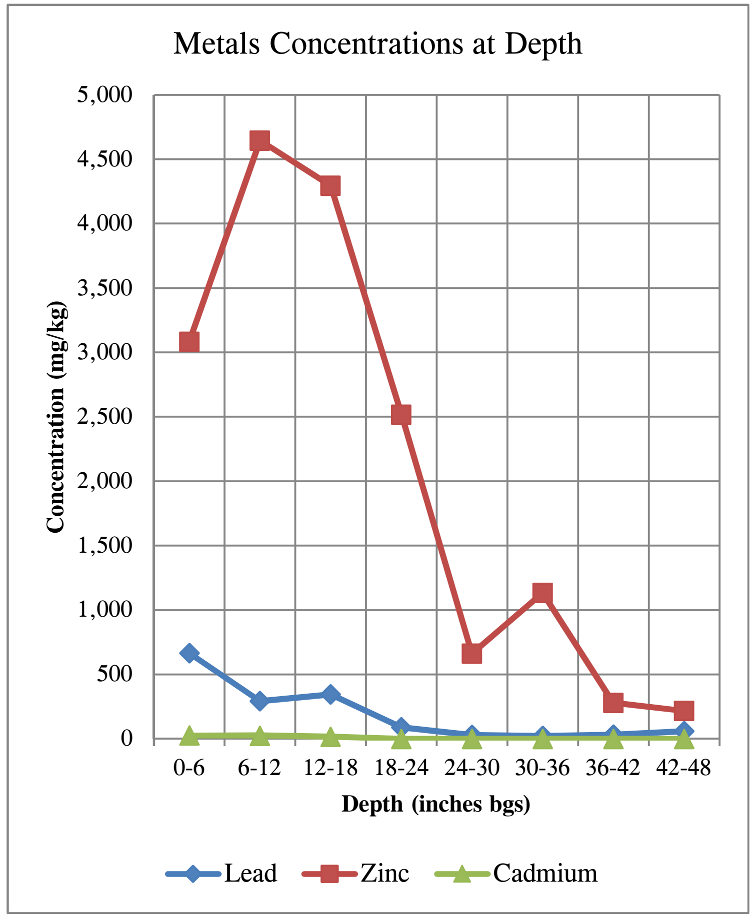
Cadmium - 7.1 mg/kg

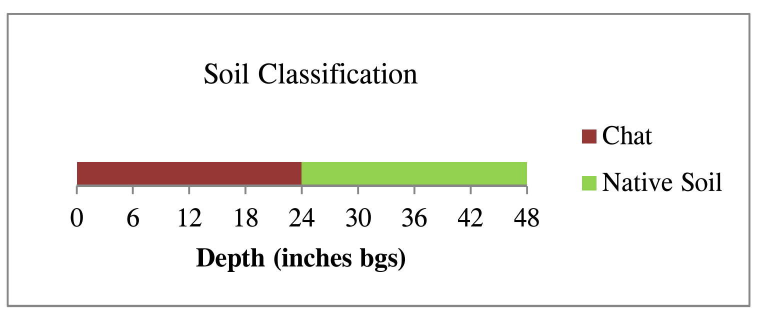
Lead - 400 mg/kg

Zinc - 2,300 mg/kg

Figure 5.3
Metals Concentrations at Depth - Location 3
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

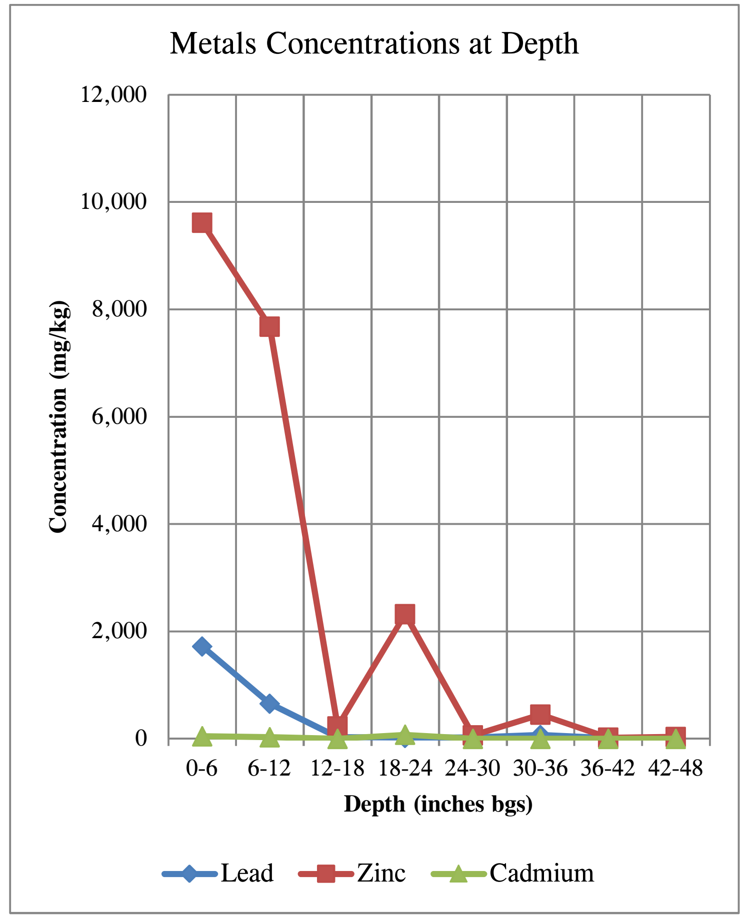
Test Pit 3A

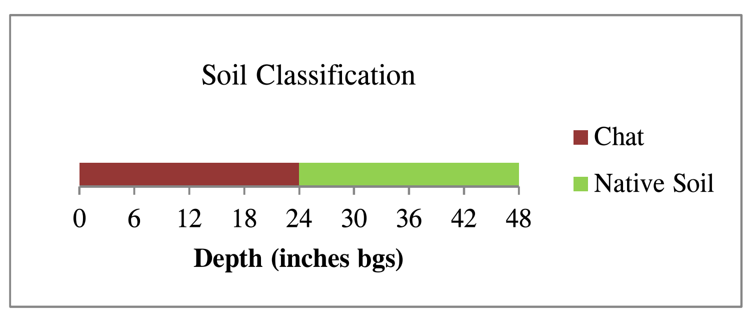




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**665**	**3,084**	**25**
6-12	**292**	**4,646**	**25**
12-18	**343**	**4,295**	**17**
18-24	**89**	**2,518**	< 14.1
24-30	**29**	**661**	< 14.6
30-36	**21**	**1,133**	< 13.9
36-42	**32**	**280**	< 13.8
42-48	**59**	**216**	< 13.4

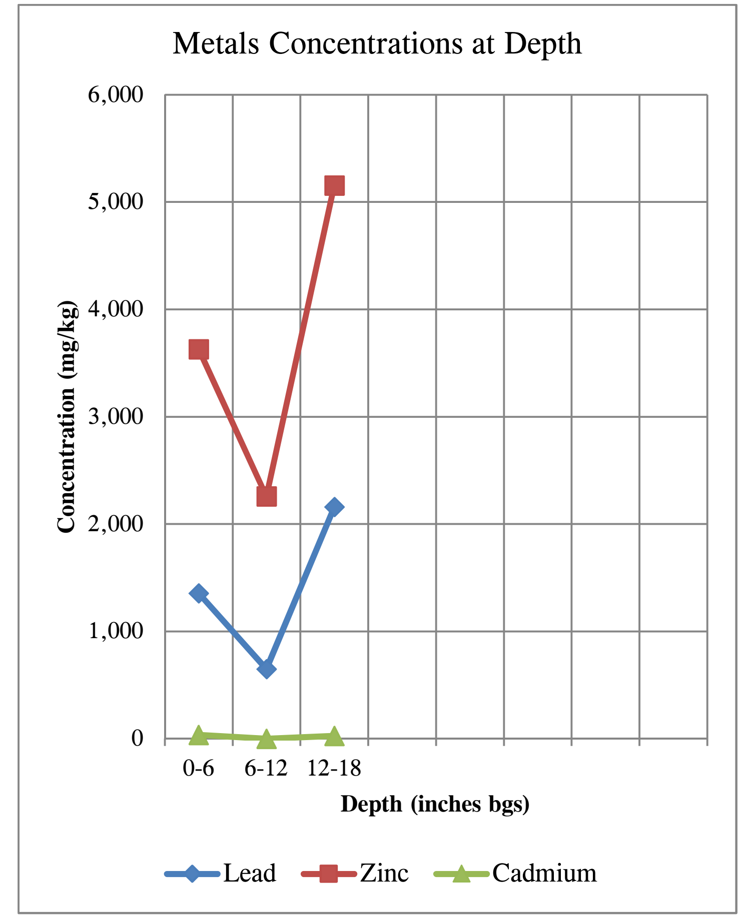
Test Pit 3B

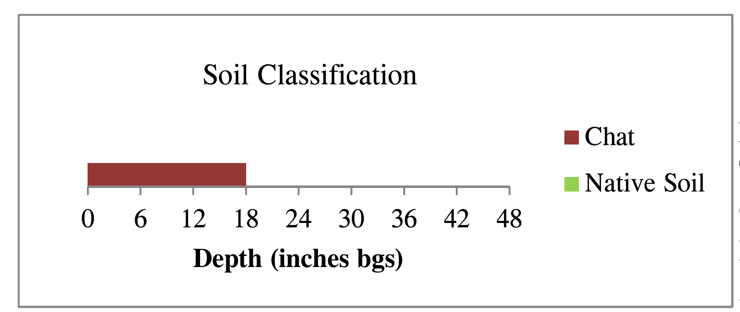




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**1,724**	**9,616**	**47**
6-12	**656**	**7,684**	**27**
12-18	**27**	**231**	< 13.5
18-24	**19**	**2,321**	**74**
24-30	**19**	**62**	< 14.1
30-36	**71**	**453**	< 13.9
36-42	**12**	**20**	< 12.8
42-48	**15**	**32**	< 14.5

Test Pit 3B-N





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**1,354**	**3,630**	**35**
6-12	**649**	**2,257**	< 15.1
12-18	**2,161**	**5,157**	**27**

Test Pit 3B-2

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**2,014**	**7,148**	**51**

Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which only one interval was collected.

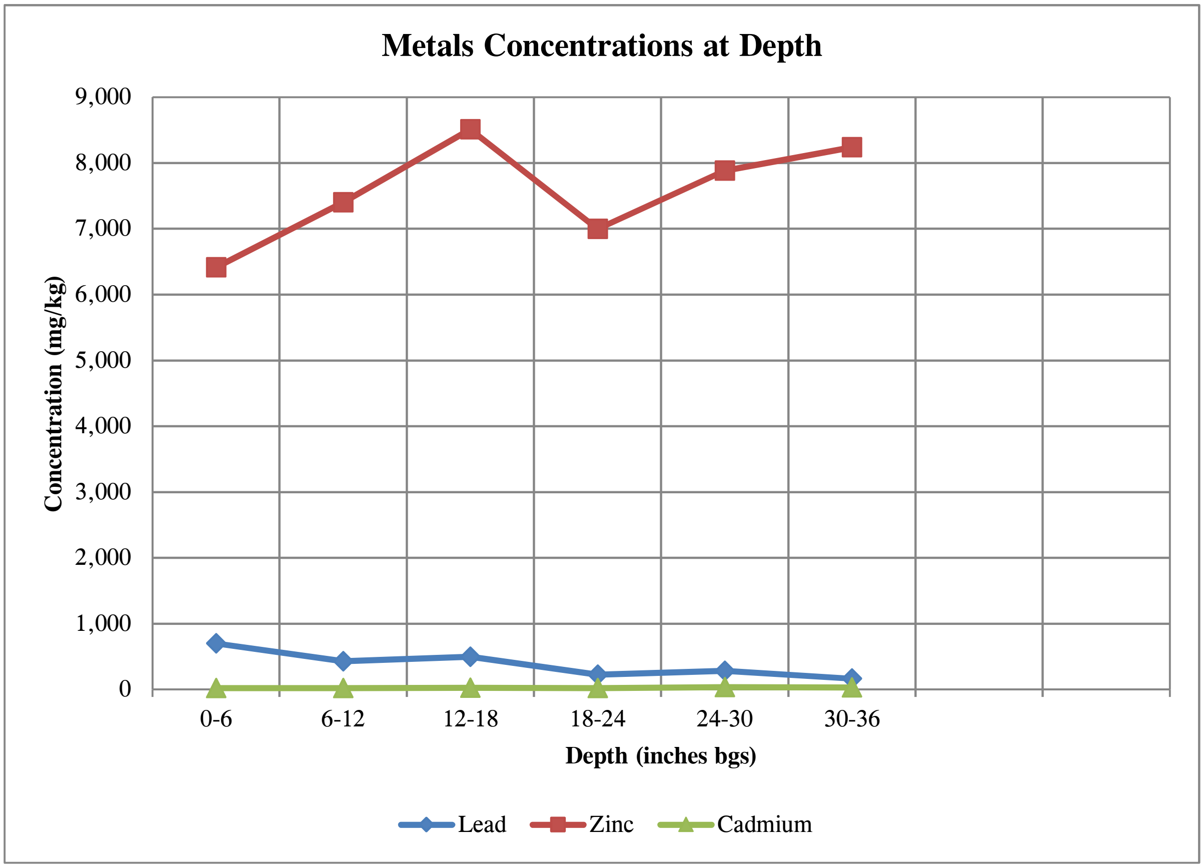
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

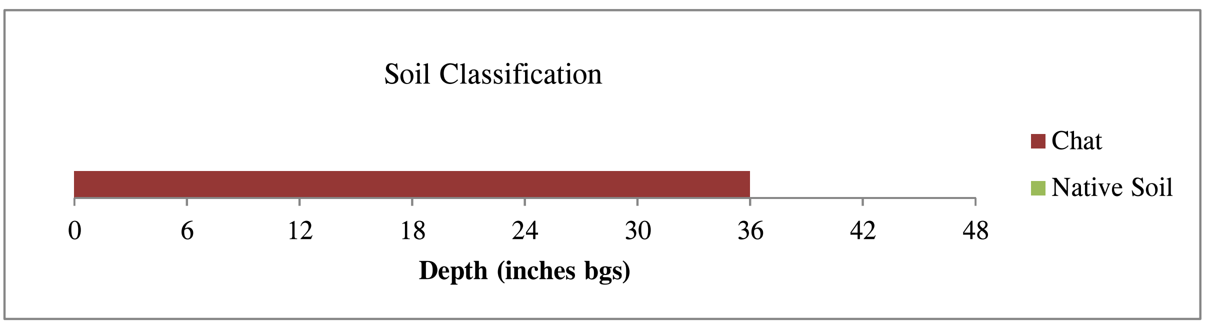
- Above Residential Screening Level

bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.4
Metals Concentrations at Depth - Location 4
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas
Field Screening Data

Test Pit 4A





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**700**	**6,412**	**21**
6-12	**432**	**7,402**	**21**
12-18	**497**	**8,510**	**26**
18-24	**226**	**6,997**	**22**
24-30	**284**	**7,883**	**34**
30-36	**164**	**8,239**	**30**

- Above Residential RSL

bgs - below ground surface

mg/kg - milligrams per kilogram

Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Residential Soil Regional Screening Levels

Total Hazard Quotient = 0.1 (June 2015)

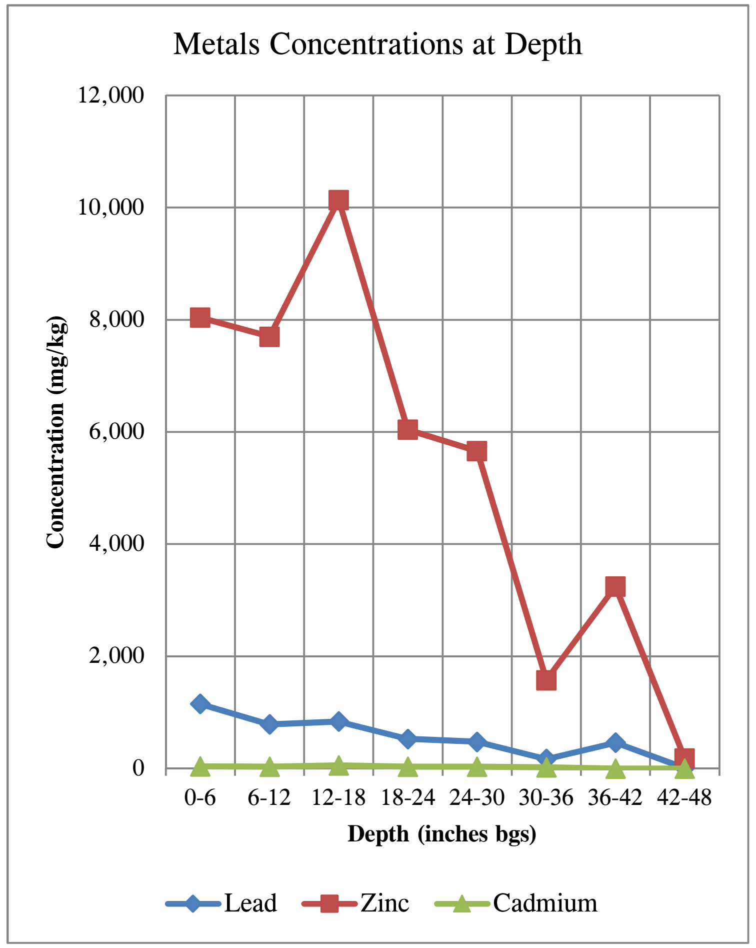
Cadmium - 7.1 mg/kg

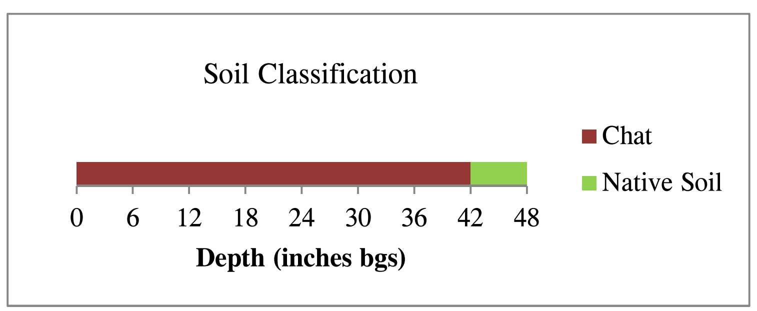
Lead - 400 mg/kg

Zinc - 2,300 mg/kg

Figure 5.5
Metals Concentrations at Depth - Location 5
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

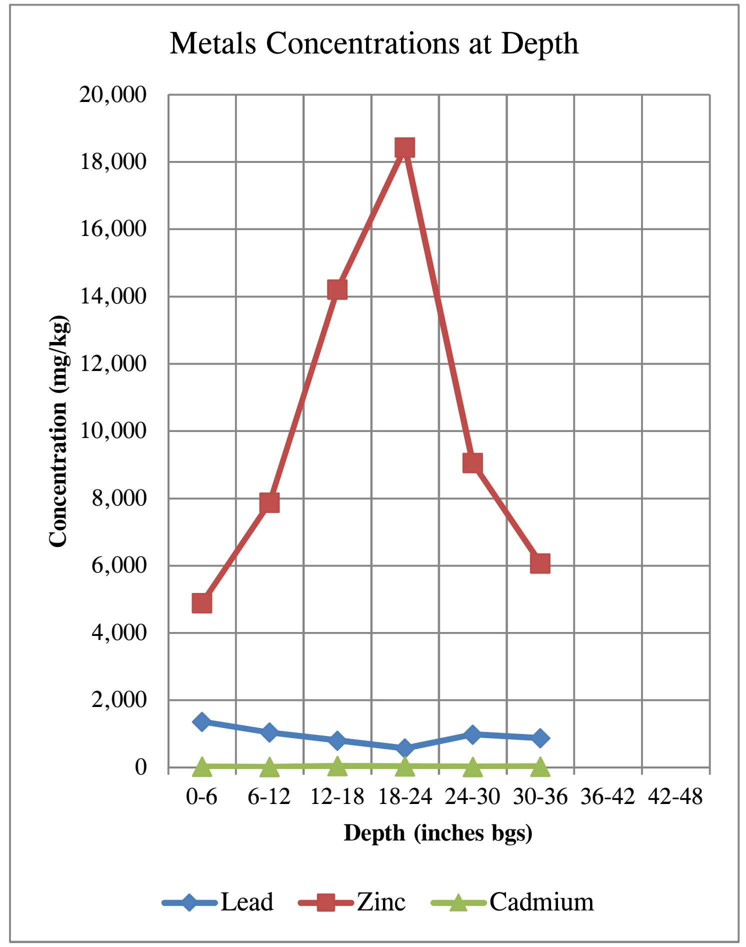
Test Pit 5A

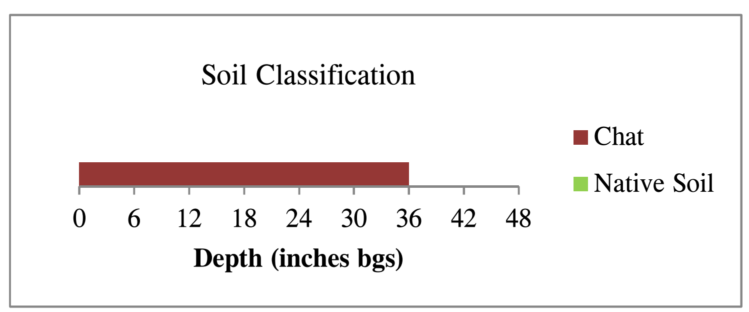




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	1,149	8,038	38
6-12	786	7,700	30
12-18	838	10,133	56
18-24	525	6,041	30
24-30	474	5,660	34
30-36	170	1,576	19
36-42	457	3,246	< 14.9
42-48	7	180	< 12.9

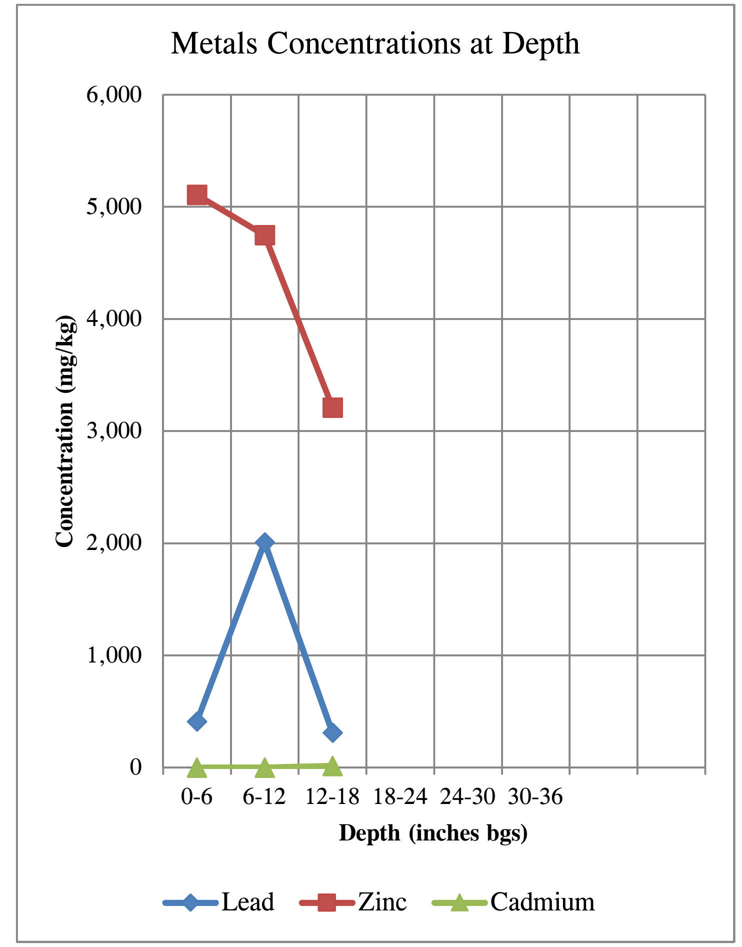
Test Pit 5B

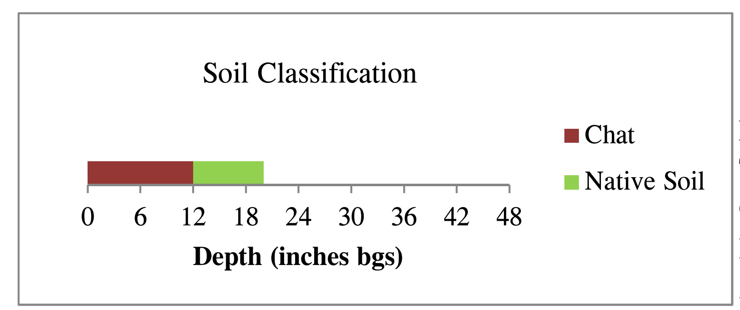




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	1,360	4,891	28
6-12	1,044	7,875	15
12-18	800	14,214	46
18-24	568	18,433	33
24-30	981	9,054	21
30-36	871	6,070	30
36-42			
42-48			

Test Pit 5B-N





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	409	5,107	< 11.8
6-12	2,009	4,748	< 15
12-18	311	3,210	14
18-24			
24-30			
30-36			

Test Pit 5B-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	572	7,946	66

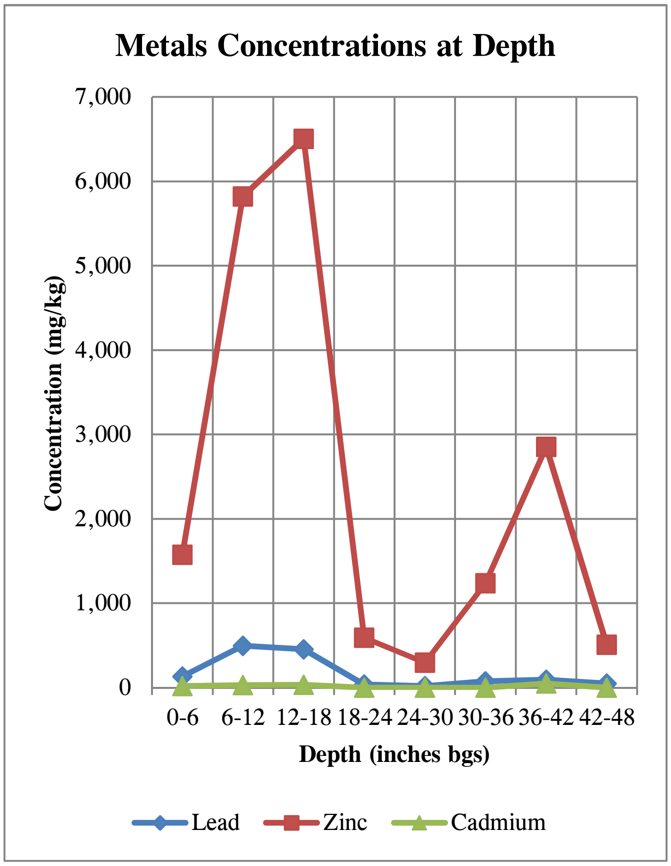
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which only one interval was collected.

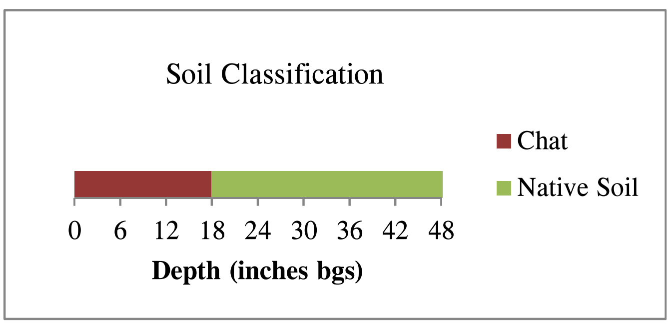
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Residential Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.6
Metals Concentrations at Depth - Location 6
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

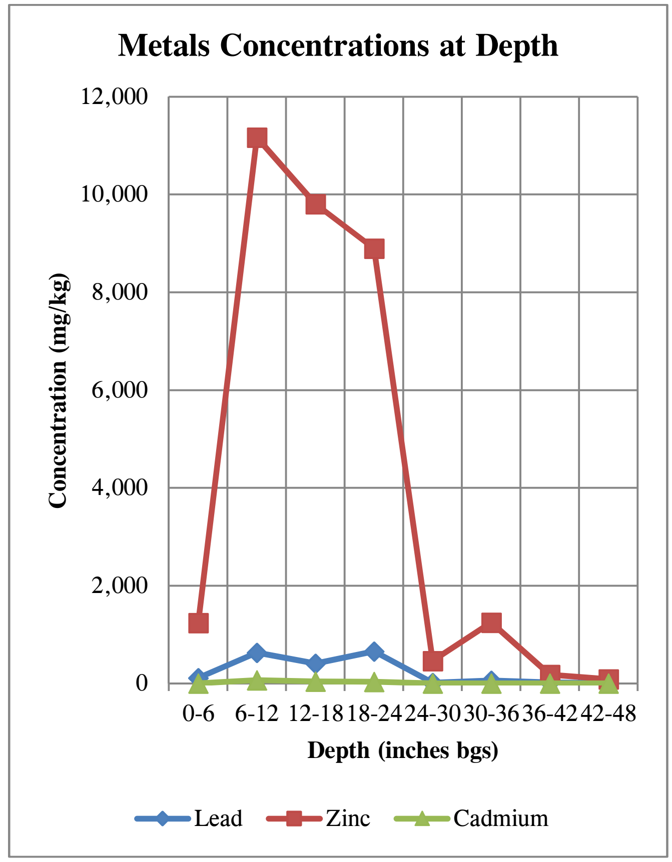
Test Pit 6A

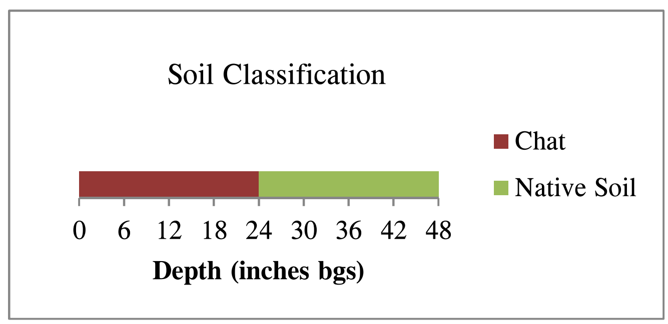




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**134**	**1,573**	**17**
6-12	**495**	**5,821**	**29**
12-18	**453**	**6,504**	**32**
18-24	**39**	**592**	< 13.7
24-30	**19**	**295**	< 13.8
30-36	**74**	**1,236**	< 13.0
36-42	**94**	**2,855**	**49**
42-48	**50**	**507**	< 14.1

Test Pit 6B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**112**	**1,241**	< 12.6
6-12	**632**	**11,168**	**71**
12-18	**409**	**9,805**	**41**
18-24	**657**	**8,898**	**32**
24-30	**13**	**463**	< 14.7
30-36	**59**	**1,249**	< 12.8
36-42	**21**	**181**	< 14.2
42-48	**12**	**90**	< 12.0

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

- Above Residential RSL

bgs - below ground surface

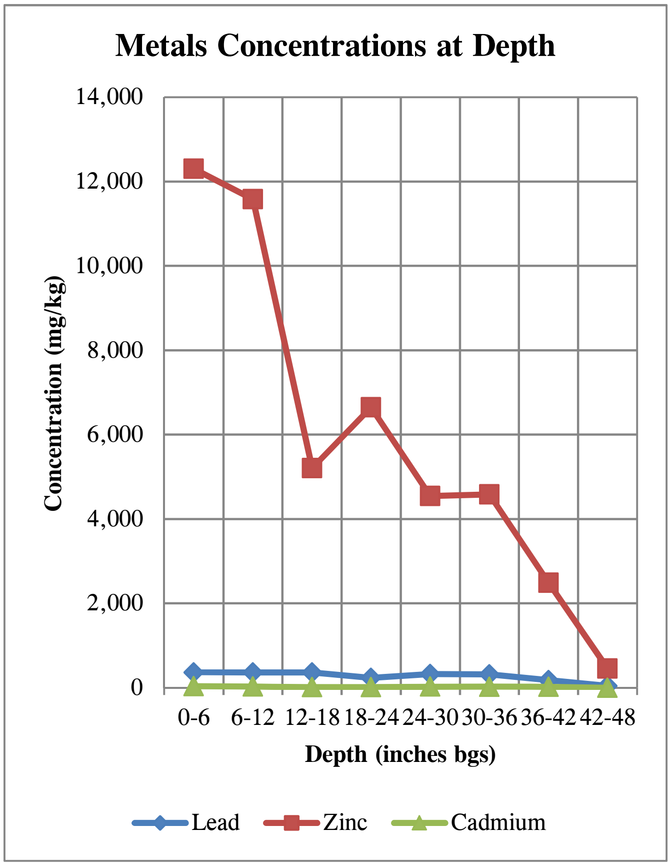
mg/kg - milligrams per kilogram

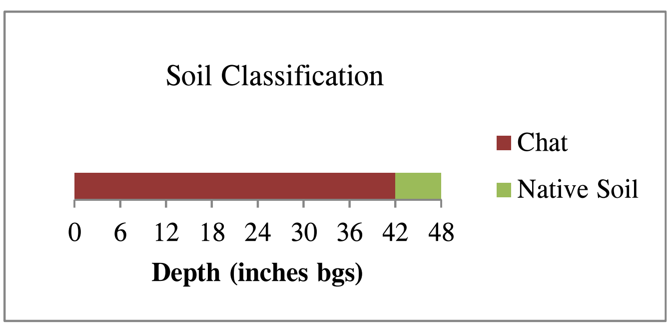
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.7
Metals Concentrations at Depth - Location 7
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

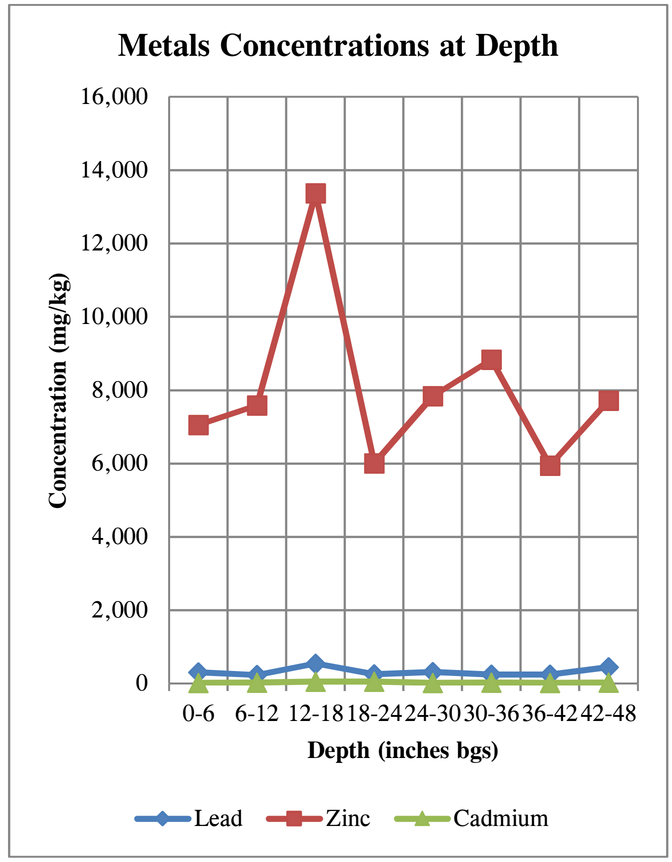
Test Pit 7A

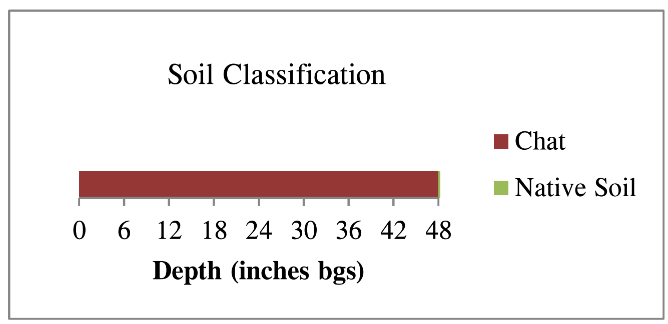




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**367**	**12,300**	**38**
6-12	**366**	**11,583**	**28**
12-18	**365**	**5,207**	**18**
18-24	**238**	**6,646**	**18**
24-30	**325**	**4,547**	**33**
30-36	**320**	**4,581**	**23**
36-42	**178**	**2,492**	**18**
42-48	**43**	**454**	< 13.9

Test Pit 7B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**310**	**7,055**	**23**
6-12	**235**	**7,585**	**28**
12-18	**547**	**13,375**	**58**
18-24	**258**	**6,004**	**55**
24-30	**317**	**7,837**	**22**
30-36	**252**	**8,838**	**26**
36-42	**252**	**5,948**	**23**
42-48	**445**	**7,720**	**33**

Residential Soil Regional Screening Levels: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

(gray box) - Above Residential RSL

bgs - below ground surface

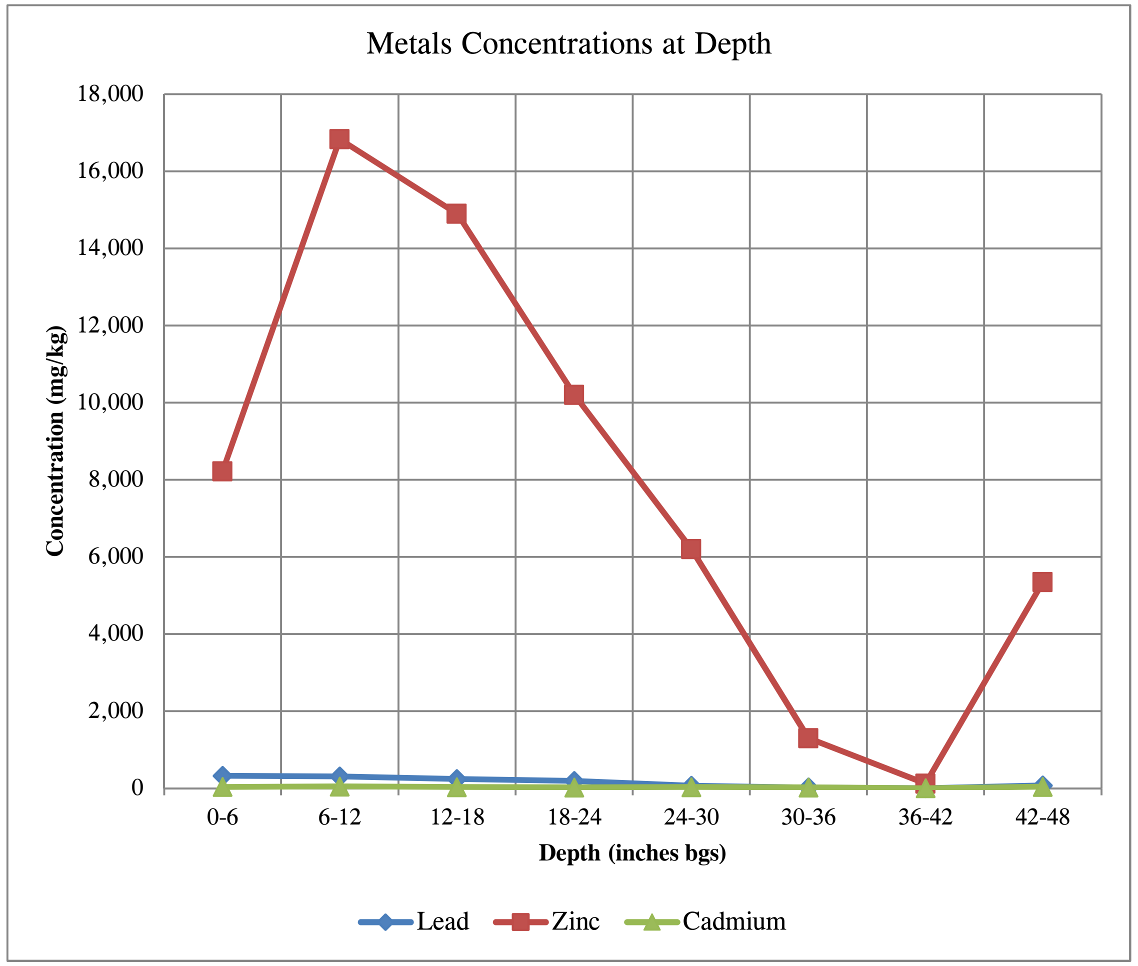
mg/kg - milligrams per kilogram

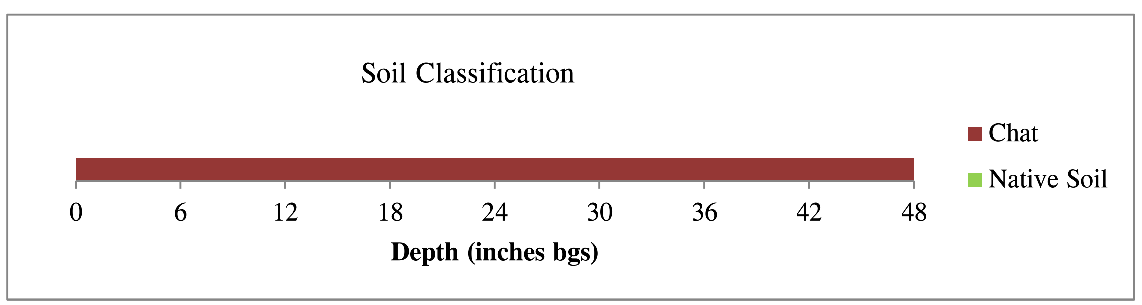
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.8
Metals Concentrations at Depth - Location 8
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

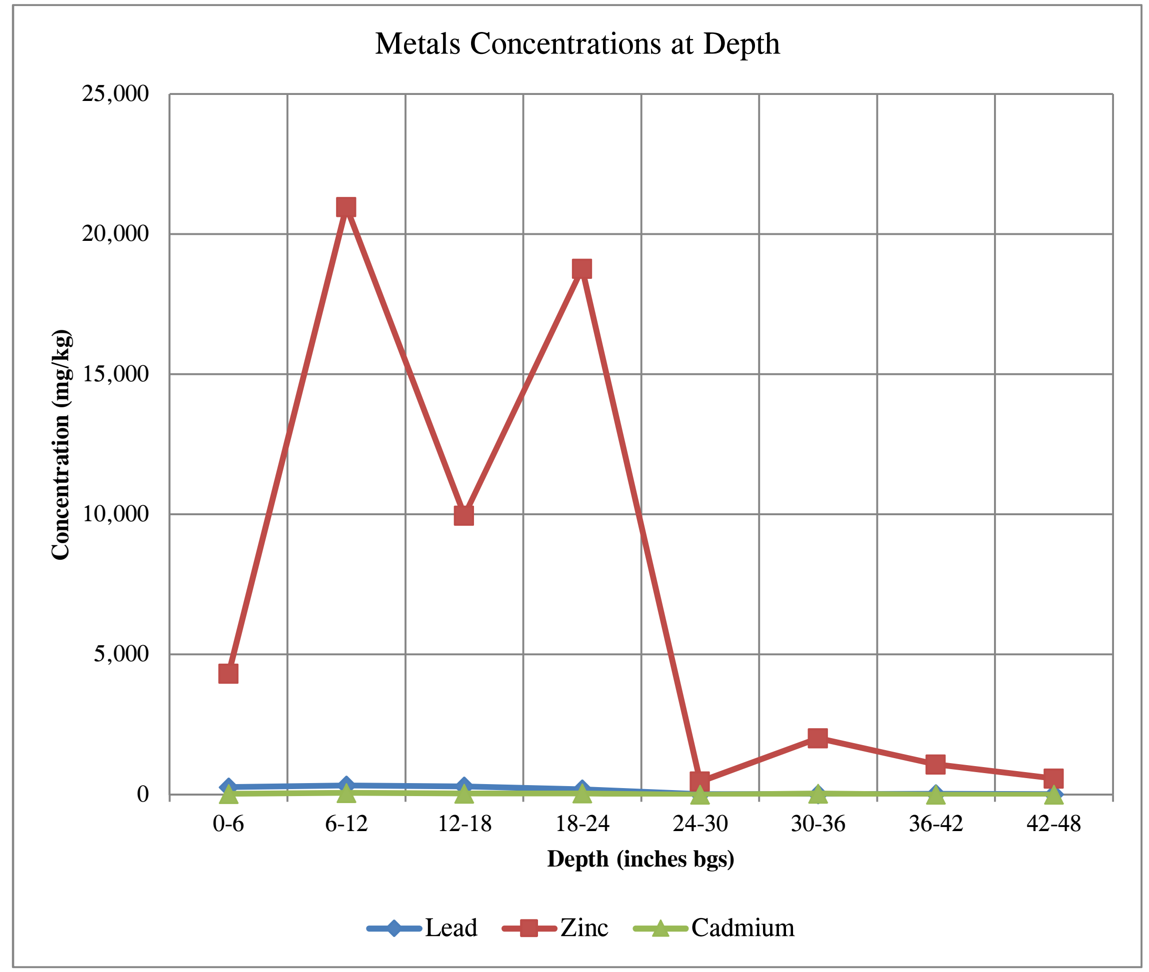
Test Pit 8A

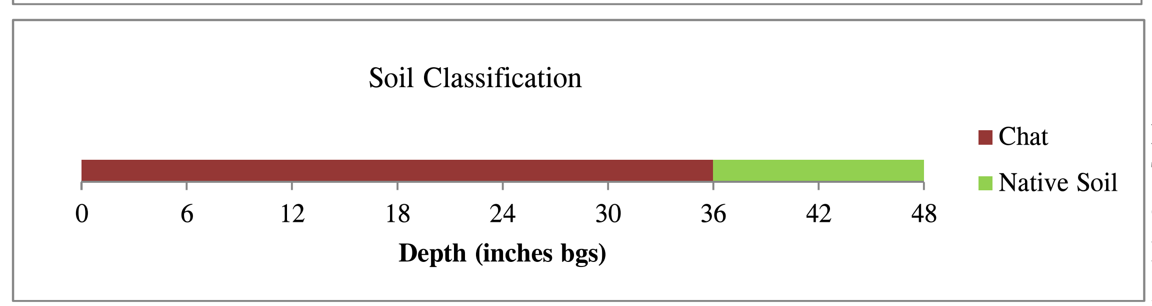




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**322**	**8,220**	**32**
6-12	**302**	**16,833**	**47**
12-18	**236**	**14,900**	**29**
18-24	**187**	**10,202**	**23**
24-30	**61**	**6,204**	**28**
30-36	**17**	**1,297**	**19**
36-42	< 10.3	**117**	< 13
42-48	**67**	**5,347**	**37**

Test Pit 8B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**269**	**4,313**	**25**
6-12	**330**	**20,967**	**63**
12-18	**294**	**9,958**	**42**
18-24	**193**	**18,767**	**45**
24-30	**14**	**466**	< 14.2
30-36	**19**	**2,010**	**37**
36-42	**28**	**1,081**	< 14.5
42-48	**18**	**577**	< 13.9

Test Pit 8A-W

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**60**	**655**	< 12.4
6-12	< 9.1	**132**	< 12.8

Test Pit 8A-E

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**39**	**356**	< 15.9
6-12	**51**	**420**	< 12.7

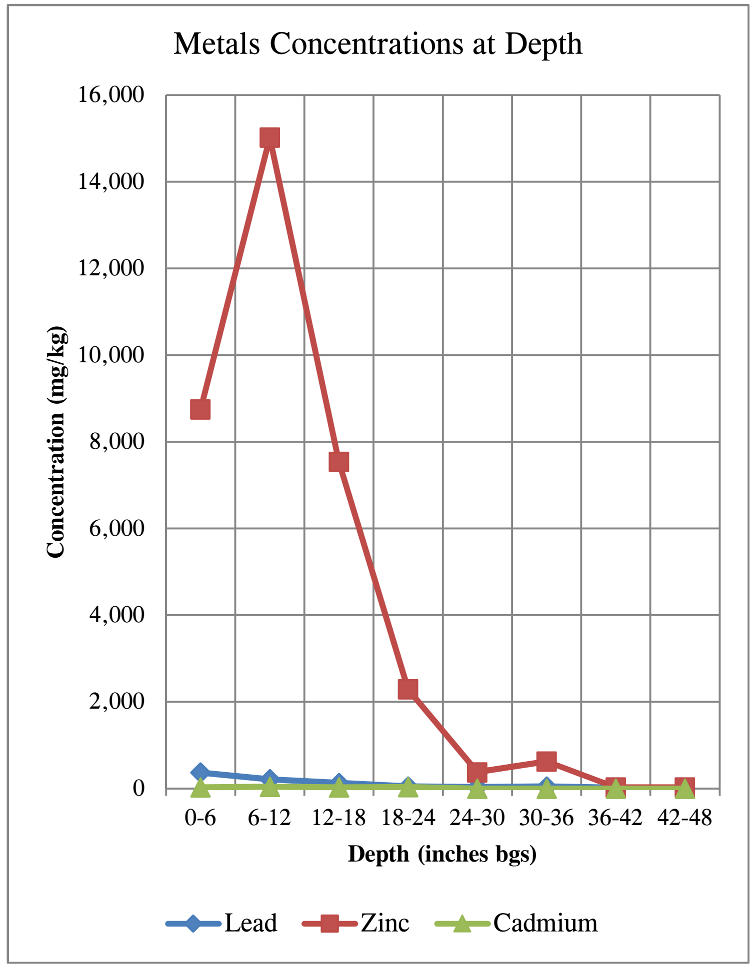
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

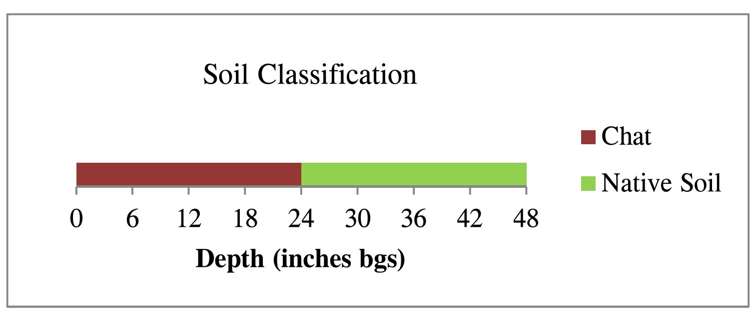
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 71 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.9
Metals Concentrations at Depth - Location 9
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

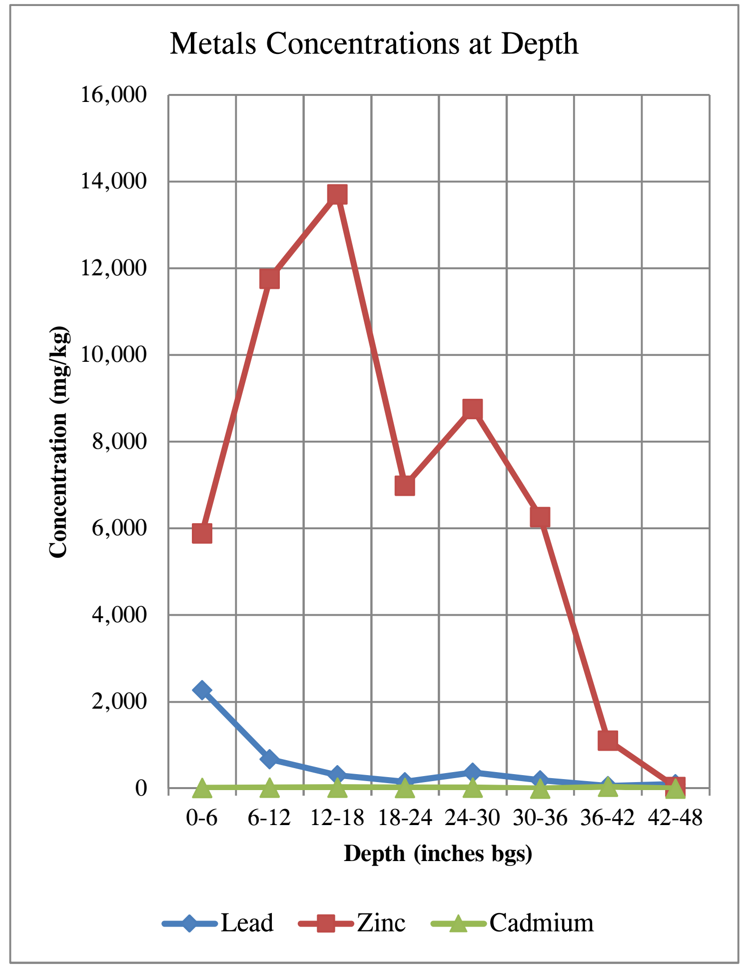
Test Pit 9A

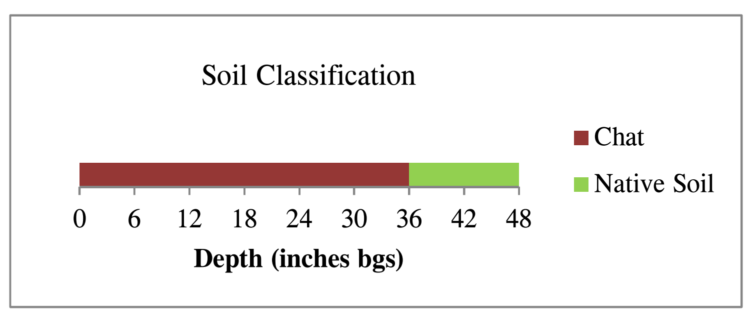




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**364**	**8,751**	**25**
6-12	**212**	**15,018**	**43**
12-18	**125**	**7,536**	**29**
18-24	**44**	**2,292**	**32**
24-30	**31**	**376**	<18.9
30-36	**44**	**623**	<17.3
36-42	**15**	**29**	<13.4
42-48	<11.1	**25**	<13.2

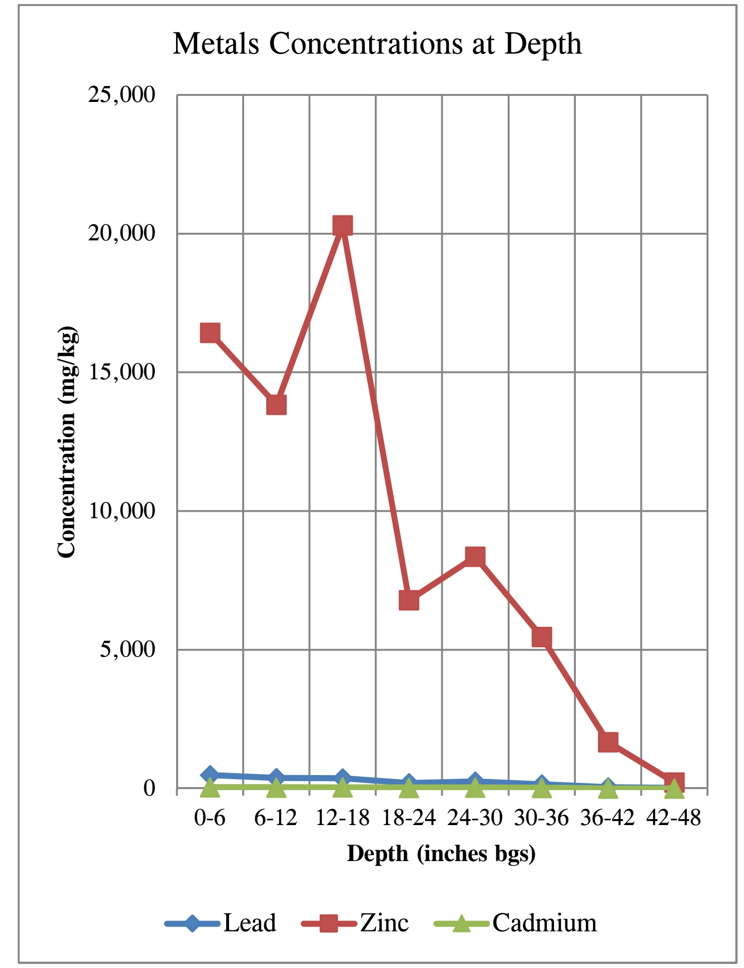
Test Pit 9B

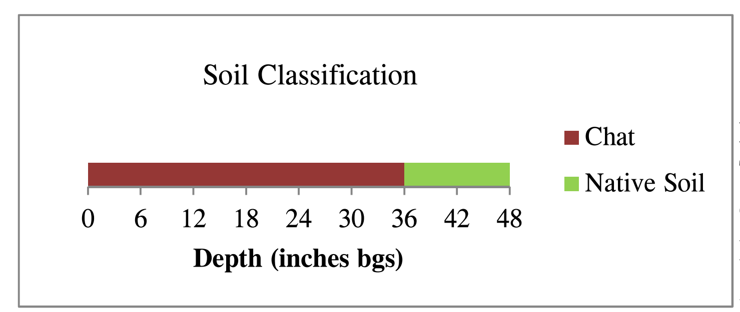




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**2,271**	**5,884**	**14**
6-12	**676**	**11,762**	**21**
12-18	**305**	**13,709**	**23**
18-24	**149**	**6,984**	**17**
24-30	**368**	**8,760**	**22**
30-36	**192**	**6,267**	<15.5
36-42	**58**	**1,104**	**40**
42-48	**100**	**36**	<14.6

Test Pit 9C





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**483**	**16,433**	**41**
6-12	**374**	**13,833**	**37**
12-18	**363**	**20,297**	**40**
18-24	**195**	**6,787**	**26**
24-30	**252**	**8,356**	**34**
30-36	**150**	**5,466**	**25**
36-42	**45**	**1,674**	<13.3
42-48	**24**	**220**	<14.6

Test Pit 9B-E

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**272**	**753**	<13.7

Test Pit 9B-W

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**93**	**2,579**	**18**
6-12	**159**	**1,816**	**20**
12-18	**272**	**753**	<13.7

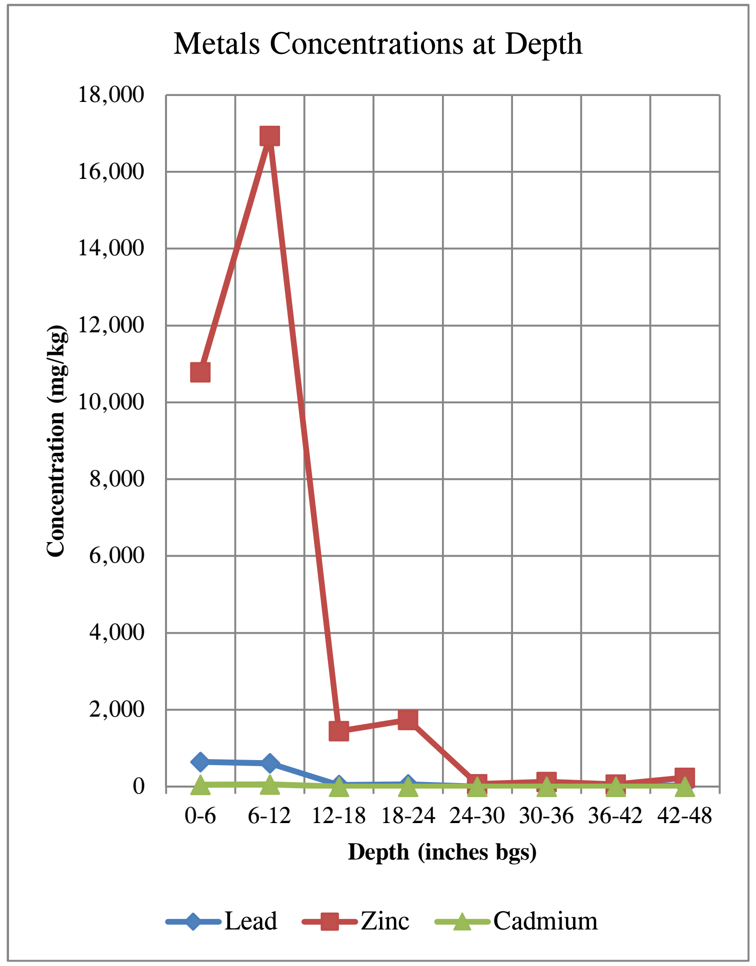
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

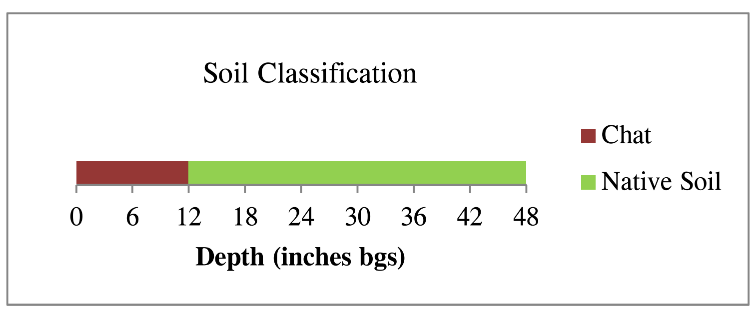
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 71 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.10
Metals Concentrations at Depth - Location 10
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

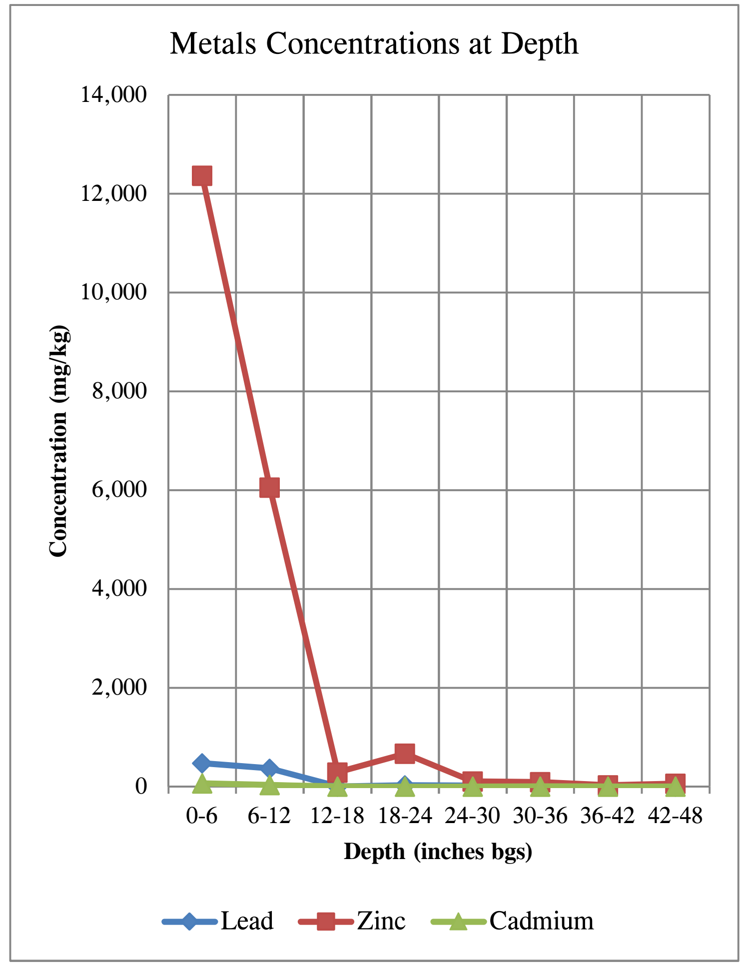
Test Pit 10A

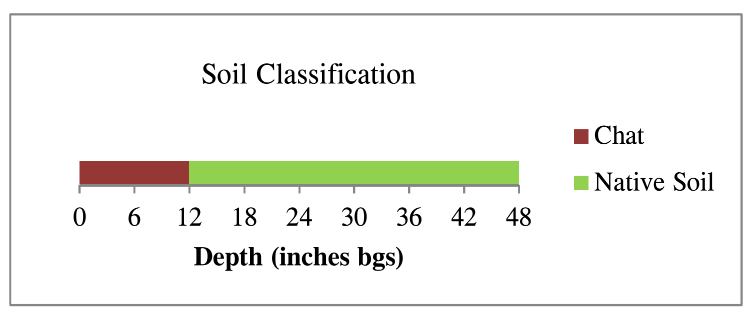




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	640	10,786	43
6-12	606	16,933	54
12-18	38	1,441	< 14.9
18-24	55	1,738	< 14.8
24-30	< 11.0	62	< 14.8
30-36	15	123	< 13.3
36-42	19	58	< 15
42-48	20	225	< 13.9

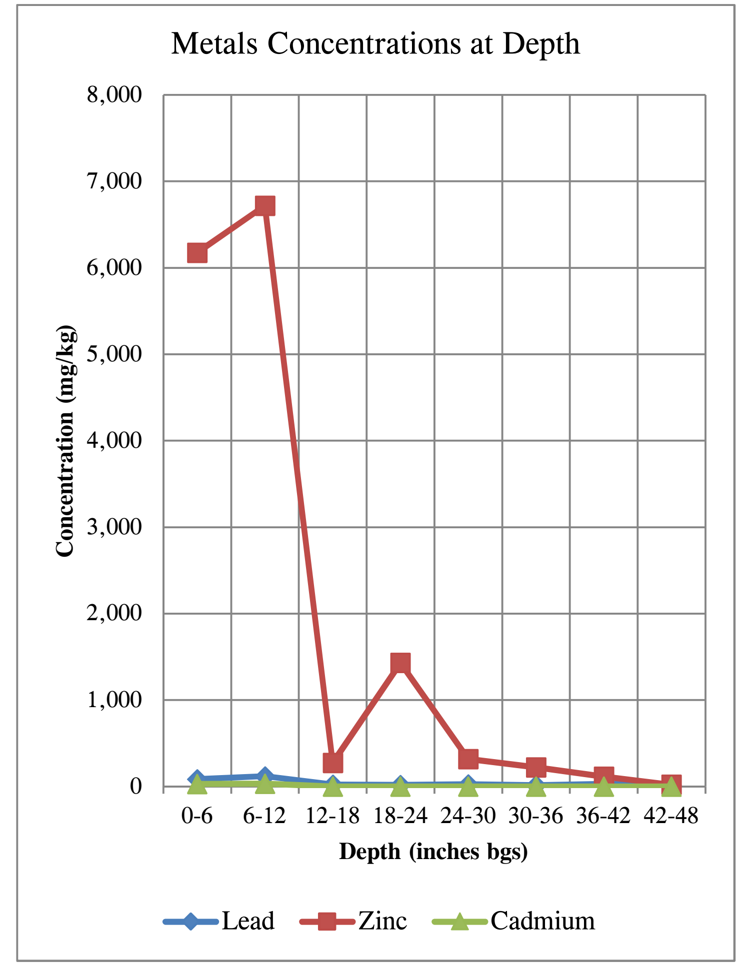
Test Pit 10B

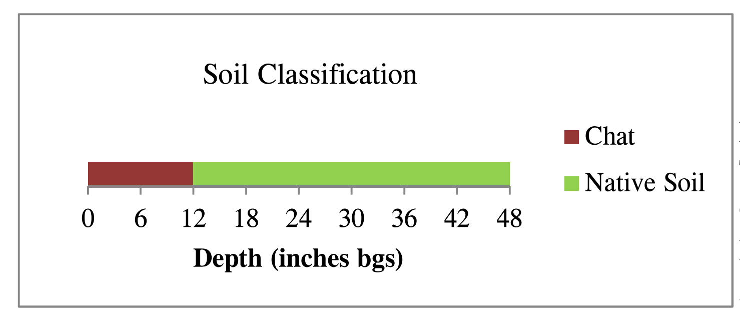




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	473	12,367	63
6-12	364	6,051	31
12-18	< 10.2	286	< 14.2
18-24	22	663	< 13.2
24-30	17	102	< 13.4
30-36	21	88	< 13.2
36-42	14	27	< 13.4
42-48	< 10.9	59	< 14.1

Test Pit 10C





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	85	6,176	27
6-12	119	6,718	32
12-18	22	273	< 13.1
18-24	19	1,431	< 15
24-30	26	318	< 12.8
30-36	14	220	< 13.5
36-42	27	114	< 14.9
42-48	16	20	< 15.2

Test Pit 10A-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	131	1,148	< 13.7
6-12	261	890	< 13.6

Test Pit 10B-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	13	94	< 13.0
6-12	16	71	< 16.7

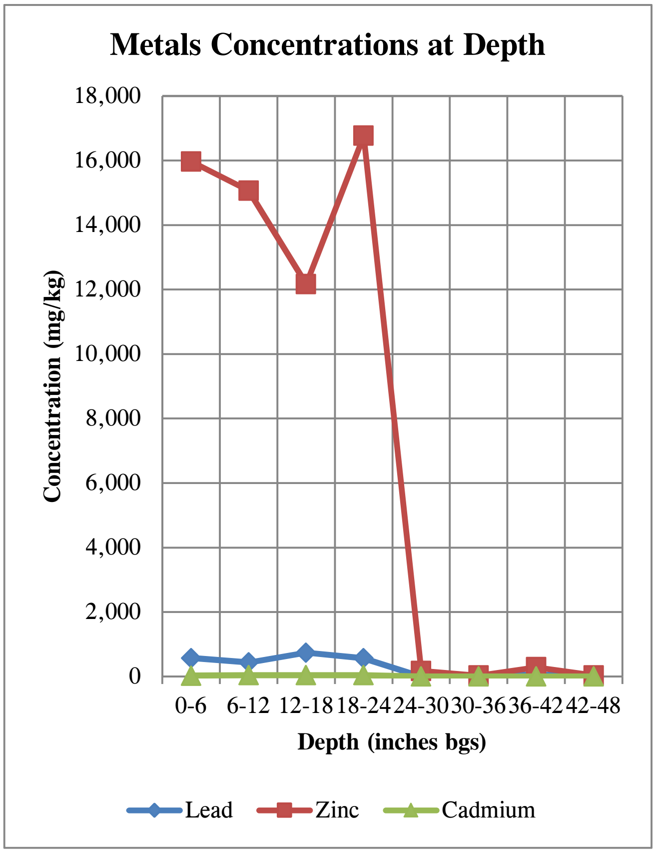
Metals concentration graphs and soil classification profiles are not shown for lateral testpits at which lead concentrations were below the Regional Screening Levels for lead.

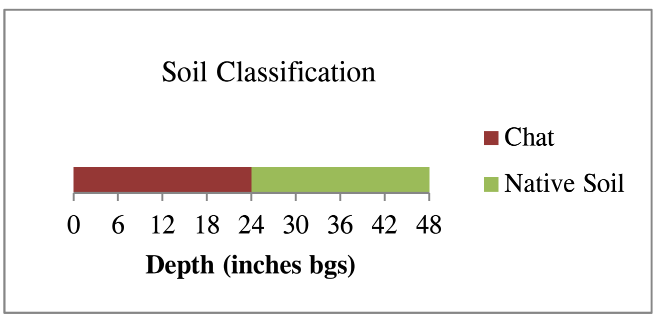
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

(gray box) - Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.11
Metals Concentrations at Depth - Location 11
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Test Pit 11A





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**573**	**15,967**	**25**
6-12	**441**	**15,067**	**41**
12-18	**739**	**12,167**	**39**
18-24	**566**	**16,767**	**38**
24-30	< 9.5	**173**	< 12.6
30-36	< 10.2	**29**	< 13.0
36-42	**63**	**289**	< 13.8
42-48	< 10.8	**35**	< 13.5

Test Pit 11A-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**37**	**244**	< 12.0

Test Pit 11A-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**74**	**871**	< 13.0

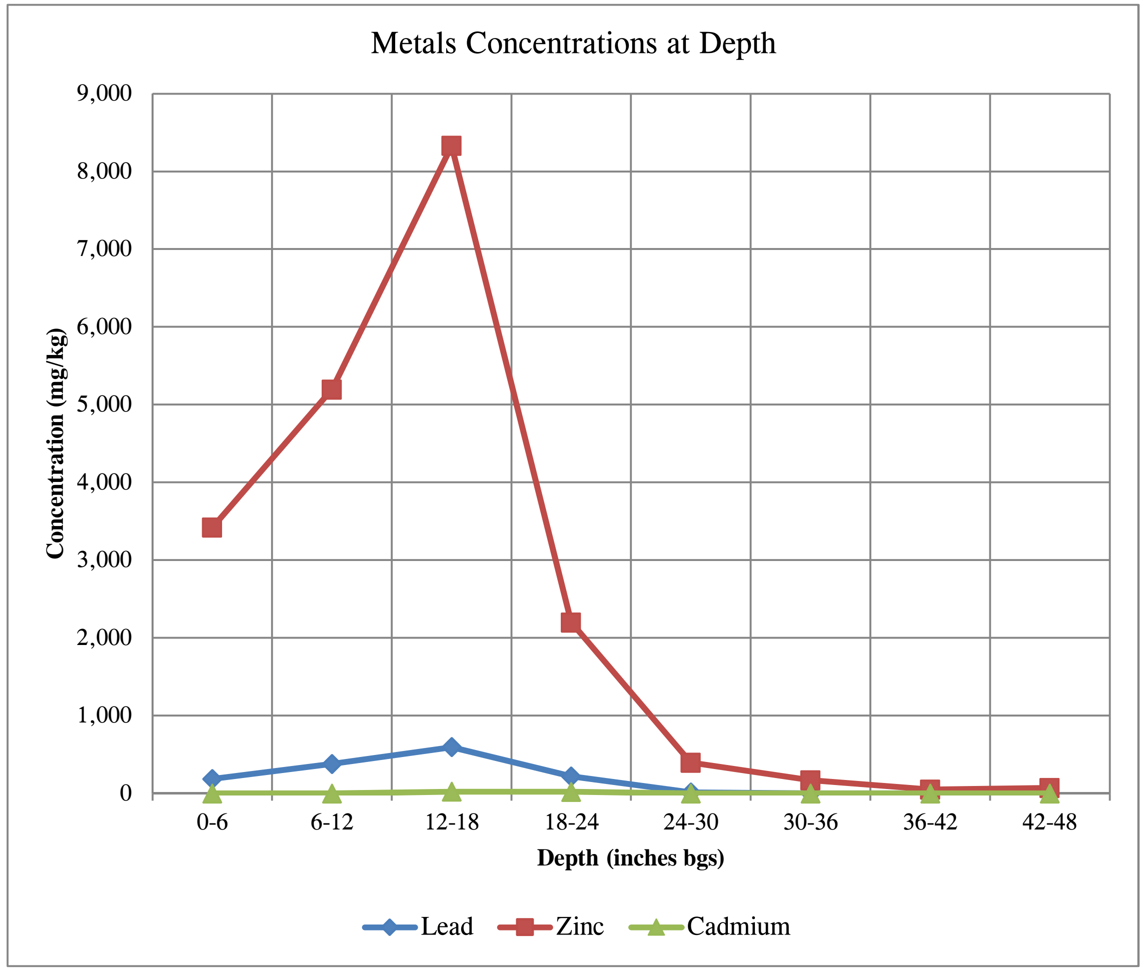
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

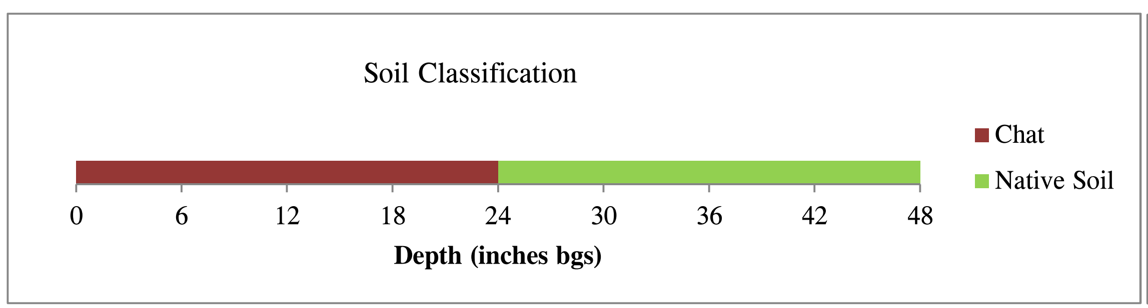
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

(grey box) - Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.12
Metals Concentrations at Depth - Location 12
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

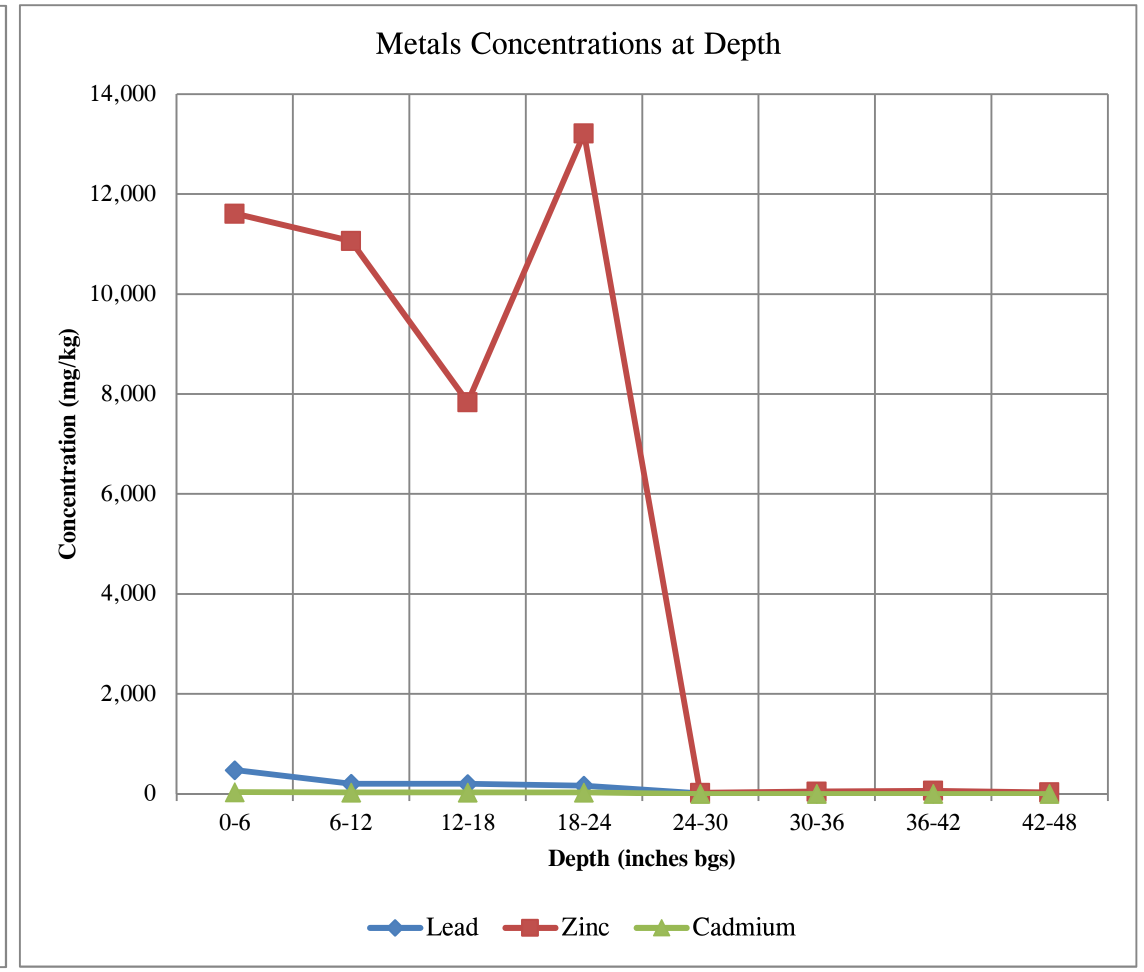
Test Pit 12A

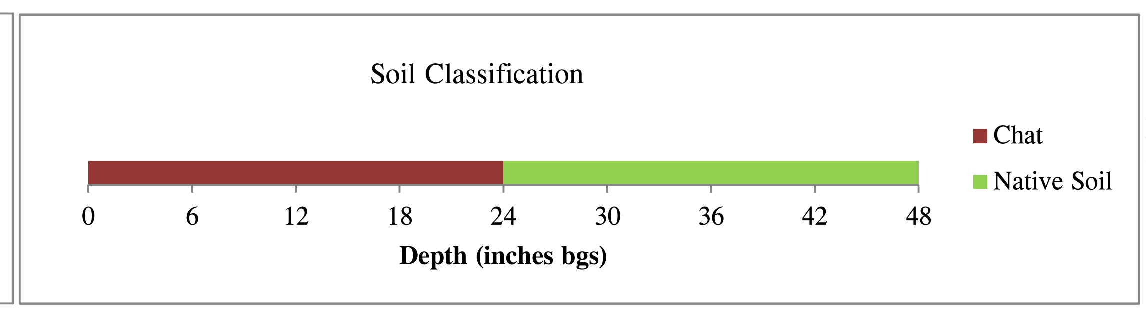




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**185**	**3,420**	< 13.4
6-12	**379**	**5,193**	< 14.3
12-18	**596**	**8,331**	**24**
18-24	**219**	**2,198**	**20**
24-30	**14**	**396**	< 13.2
30-36	< 11.6	**170**	< 13.3
36-42	< 9.5	**51**	< 12.8
42-48	< 11.0	**70**	< 13.0

Test Pit 12B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**478**	**11,610**	**37**
6-12	**204**	**11,063**	**30**
12-18	**200**	**7,840**	**27**
18-24	**166**	**13,215**	**27**
24-30	**12**	**23**	< 13.2
30-36	< 10.3	**46**	< 13.4
36-42	< 11.8	**64**	< 13.6
42-48	**16**	**32**	< 16.0

Test Pit 12B-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**52**	**577**	< 10.9

Test Pit 12B-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**65**	**545**	< 12.4

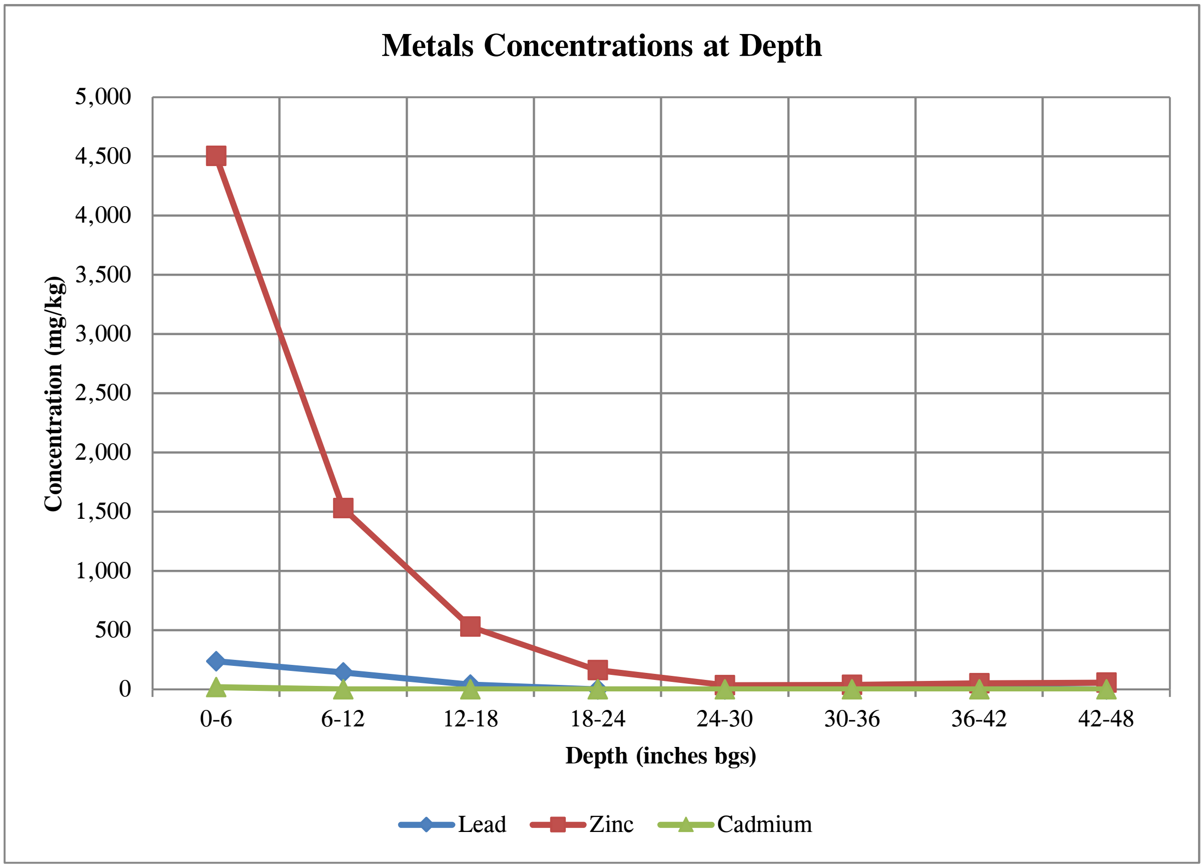
Metals concentration graphs and boring log profiles are not shown for lateral testpits at which lead concentrations were below the Regional Screening Levels for lead.

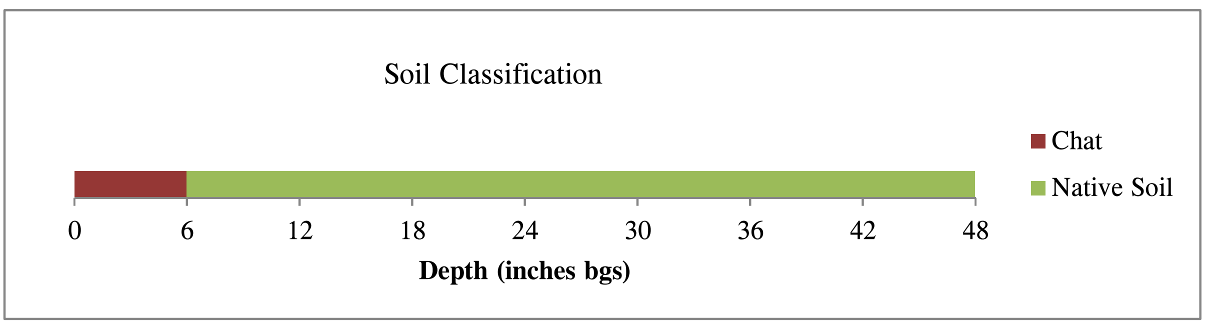
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.13a
Metals Concentrations at Depth - Location 13-Lawton
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Test Pit 13A





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**238**	**4,504**	**19**
6-12	**145**	**1,530**	< 12.9
12-18	**41**	**532**	< 13.2
18-24	< 11.2	**163**	< 13.8
24-30	< 10	**37**	< 12.8
30-36	**17**	**39**	< 13.4
36-42	**12**	**52**	< 12.2
42-48	< 9.4	**57**	< 13.2

- Above Residential RSL

bgs - below ground surface

mg/kg - milligrams per kilogram

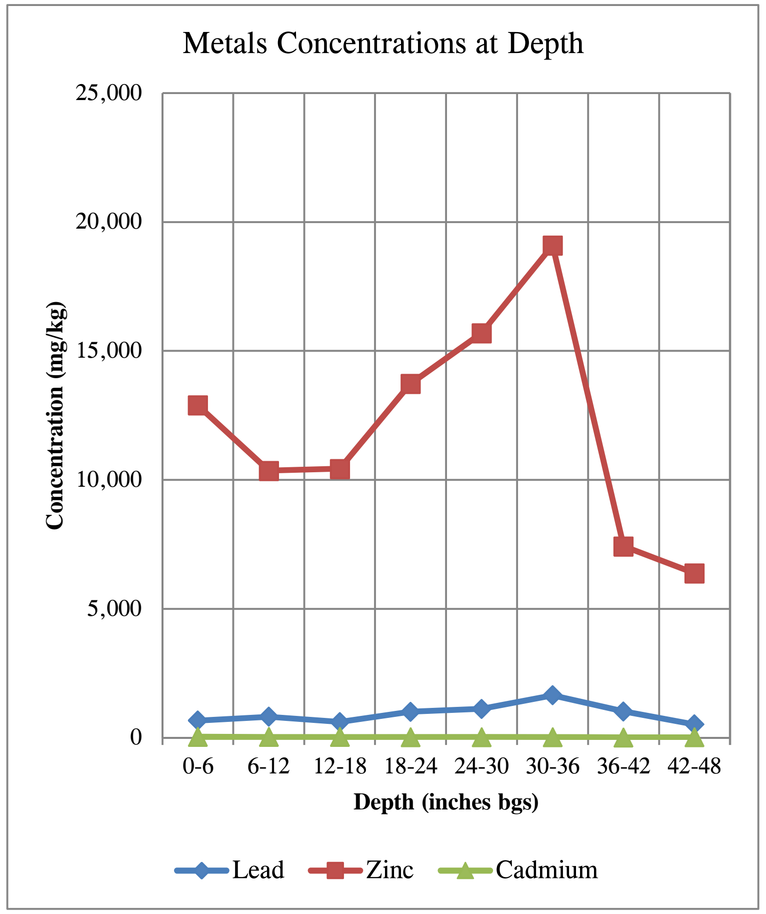
Bold - Detection

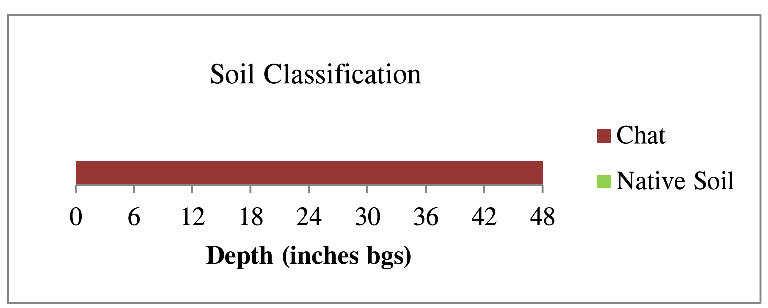
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

Figure 5.13b
Metals Concentrations at Depth - Location 13-Baxter
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

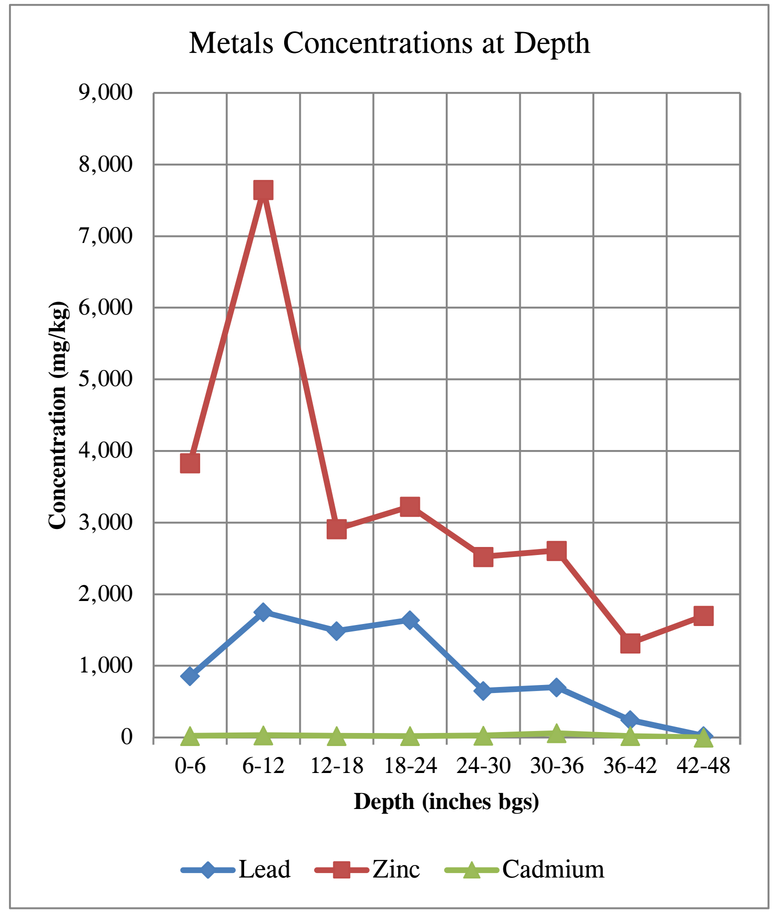
Test Pit 13A

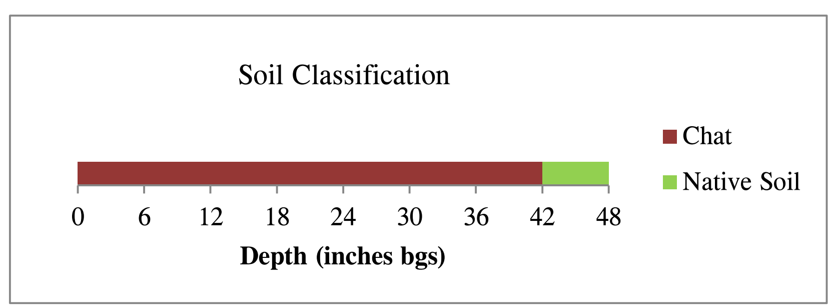




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	672	12,900	43
6-12	823	10,357	38
12-18	619	10,433	41
18-24	1,012	13,733	33
24-30	1,123	15,700	35
30-36	1,654	19,100	33
36-42	1,029	7,429	22
42-48	523	6,391	26

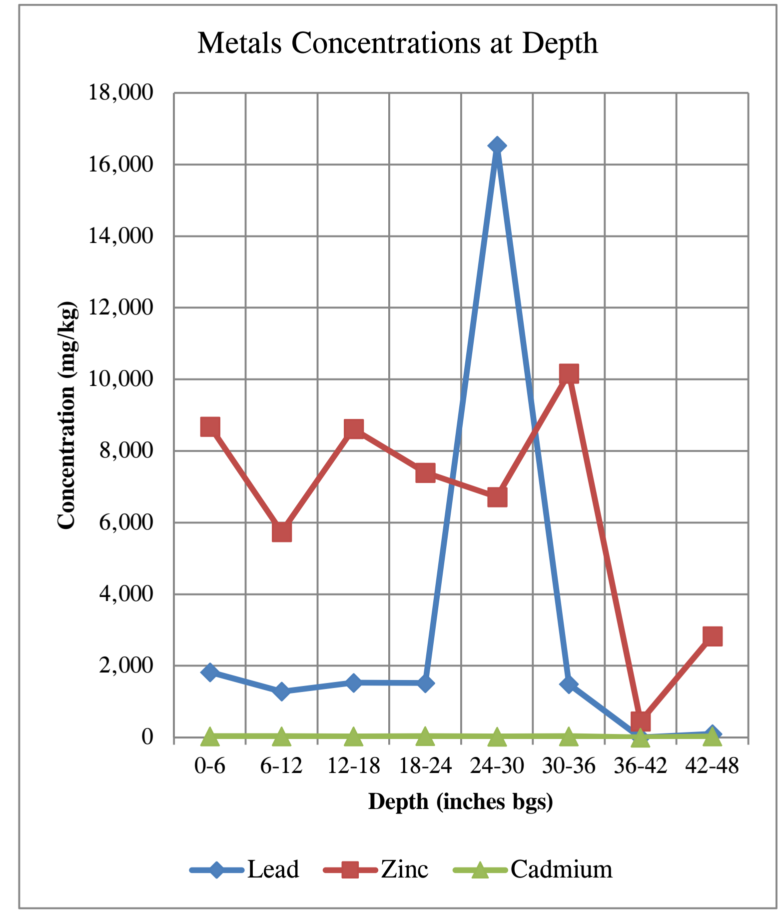
Test Pit 13B

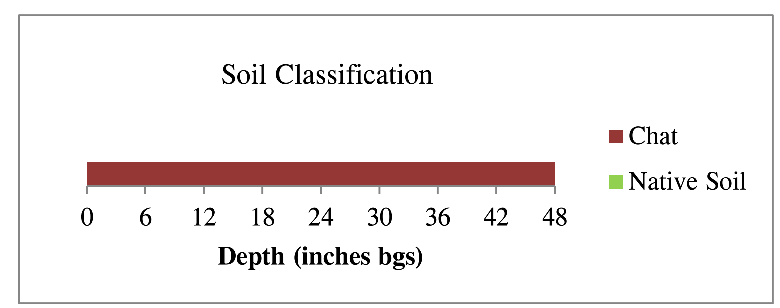




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	856	3,834	21
6-12	1,750	7,648	31
12-18	1,488	2,912	23
18-24	1,641	3,226	20
24-30	651	2,525	27
30-36	700	2,608	60
36-42	244	1,315	20
42-48	24	1,700	<13.3

Test Pit 13C





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	1,820	8,686	32
6-12	1,282	5,743	33
12-18	1,531	8,619	30
18-24	1,518	7,398	41
24-30	16,533	6,724	26
30-36	1,492	10,169	38
36-42	<9.3	452	<13.7
42-48	96	2,831	30

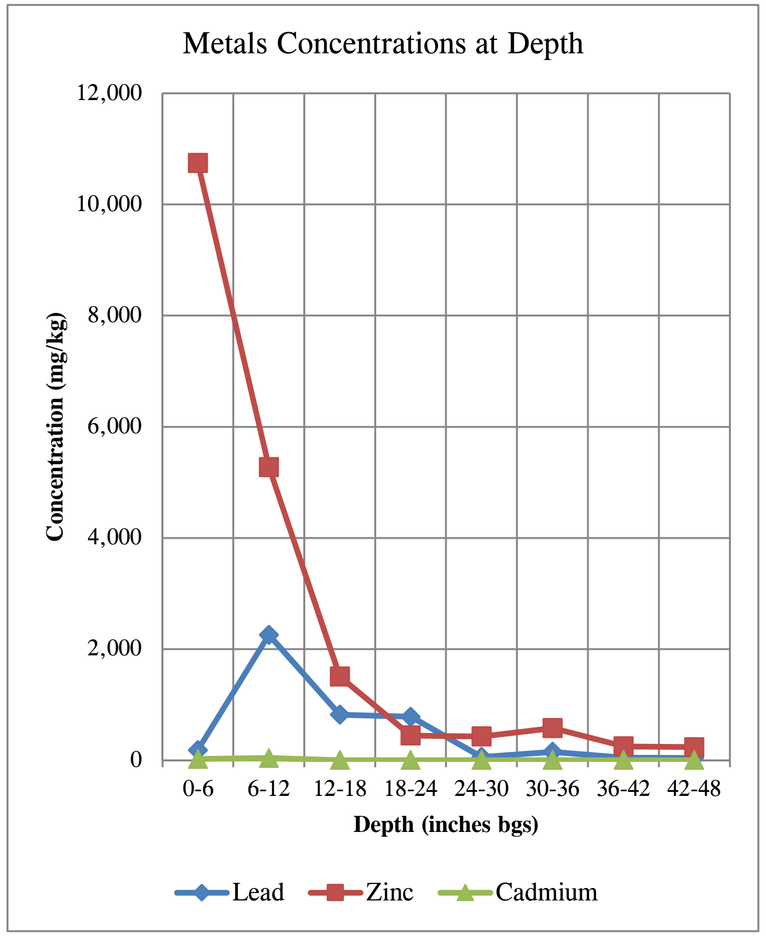
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

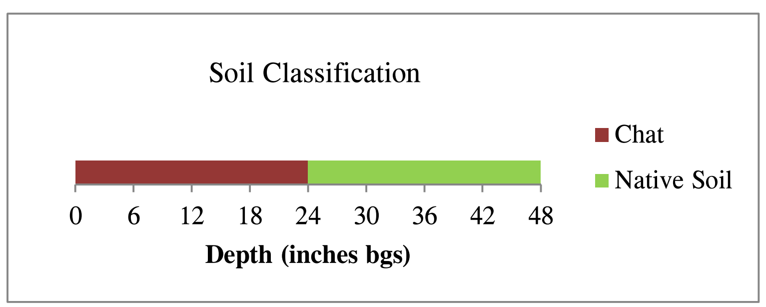
- Above Regional Screening Level

bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.13b (Continued)
Metals Concentrations at Depth - Location 13-Baxter
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

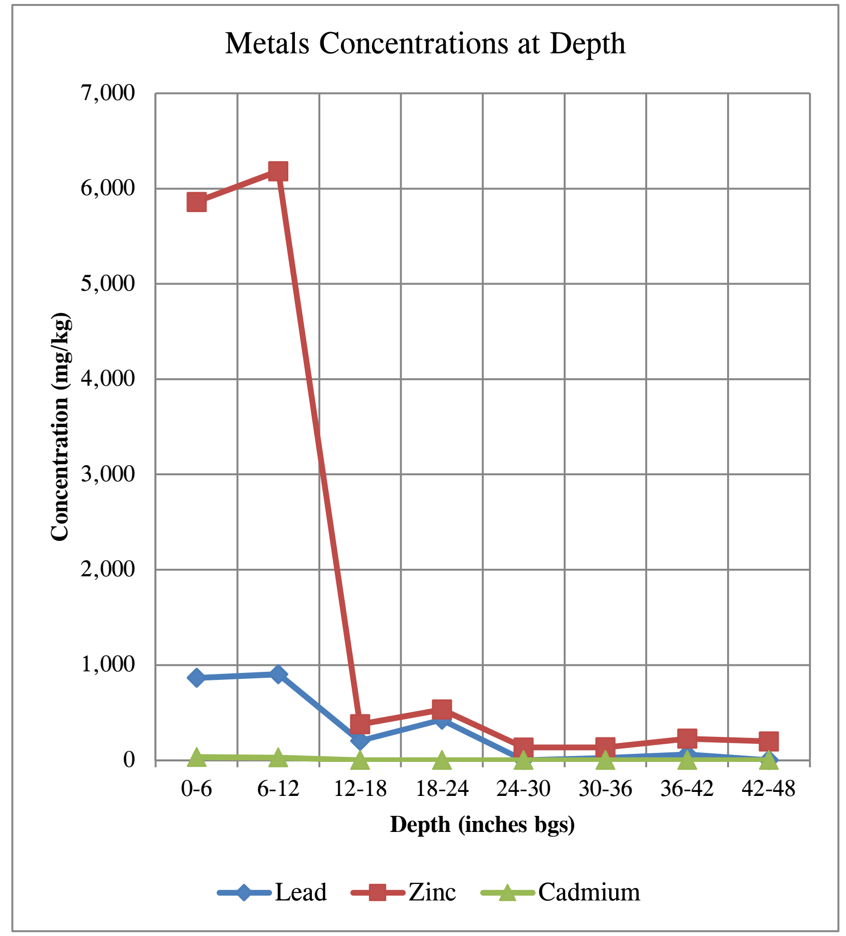
Test Pit 13D

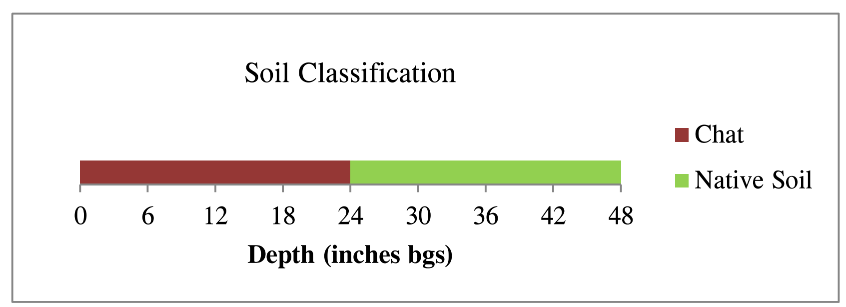




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**183**	**10,745**	**22**
6-12	**2,255**	**5,275**	**36**
12-18	**820**	**1,505**	< 13.4
18-24	**782**	**447**	< 14.5
24-30	**59**	**428**	< 14.4
30-36	**150**	**579**	< 12.9
36-42	**42**	**249**	< 13.0
42-48	**43**	**235**	< 13.7

Test Pit 13E





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**865**	**5,860**	**32**
6-12	**902**	**6,183**	**28**
12-18	**203**	**377**	< 13.7
18-24	**426**	**531**	< 13.3
24-30	< 10.0	**133**	< 12.3
30-36	**25**	**135**	< 13.3
36-42	**62**	**226**	< 12.0
42-48	< 9.9	**197**	< 13.0

Test Pit 13E-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**1,255**	**4,540**	< 13.4

Test Pit 13B-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**1,168**	**1,537**	< 11.6

Test Pit 13E-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**652**	**4,153**	< 13.5

Test Pit 13B-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**301**	**3,469**	< 10.7

Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which only one interval was collected.

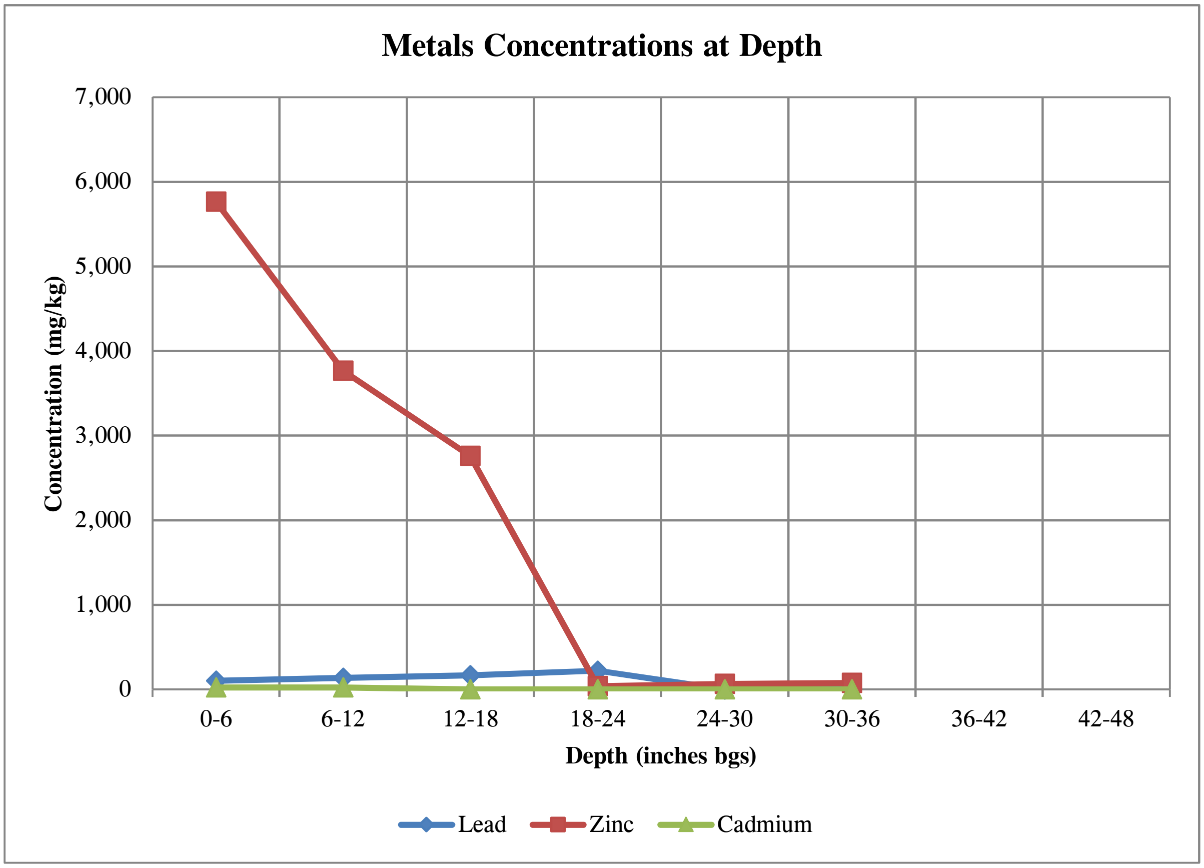
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

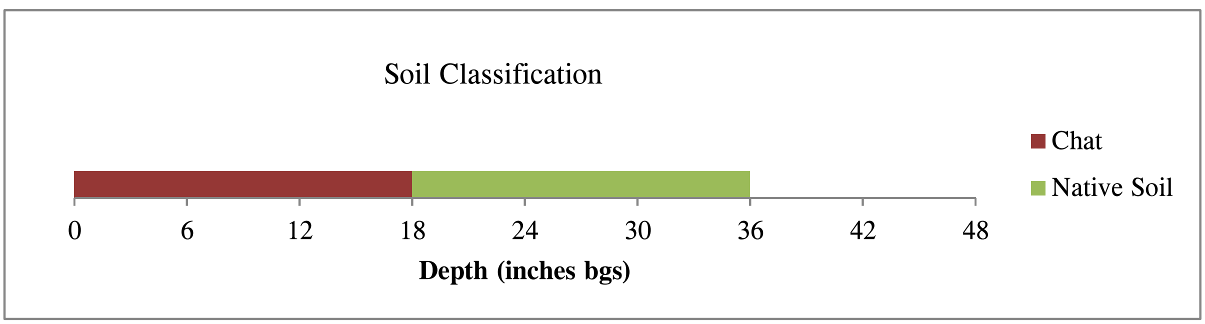
- Above Regional Screening Level

bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.14
Metals Concentrations at Depth - Location 14
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Test Pit 14A





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**104**	**5,763**	**24**
6-12	**136**	**3,765**	**25**
12-18	**169**	**2,760**	< 13.7
18-24	**222**	**38**	< 13.2
24-30	< 9.8	**64**	< 11.9
30-36	**15**	**75**	< 12.2
36-42			
42-48			

- Above Residential RSL

bgs - below ground surface

mg/kg - milligrams per kilogram

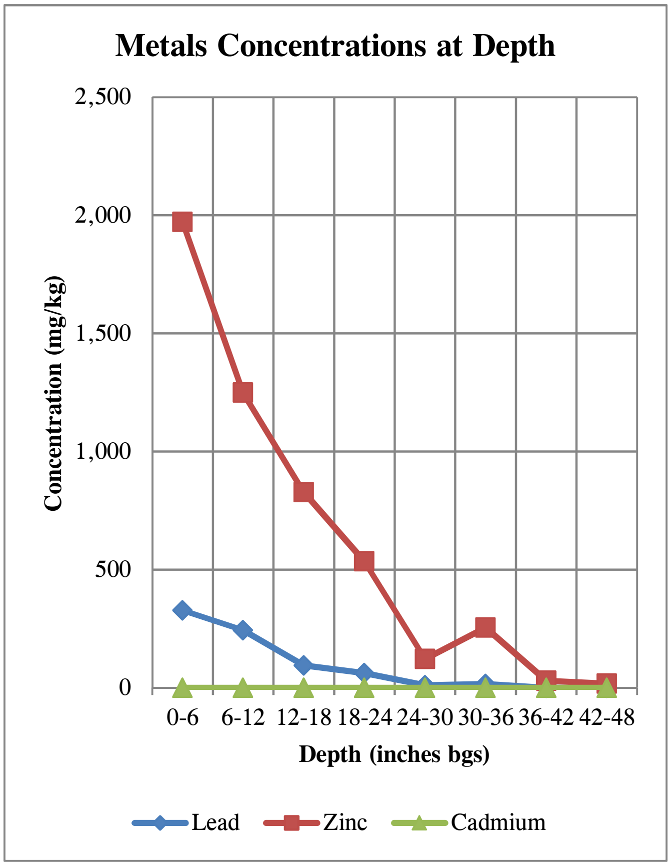
Bold - Detection

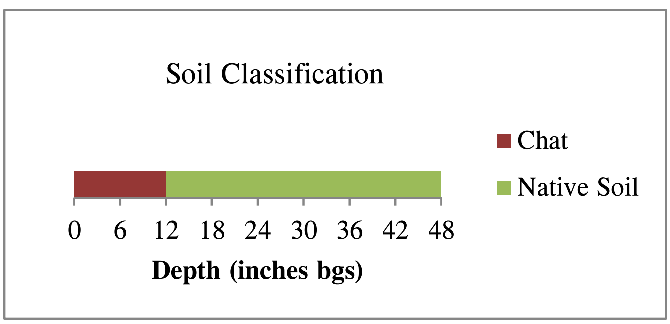
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

Figure 5.15
Metals Concentrations at Depth - Location 15
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

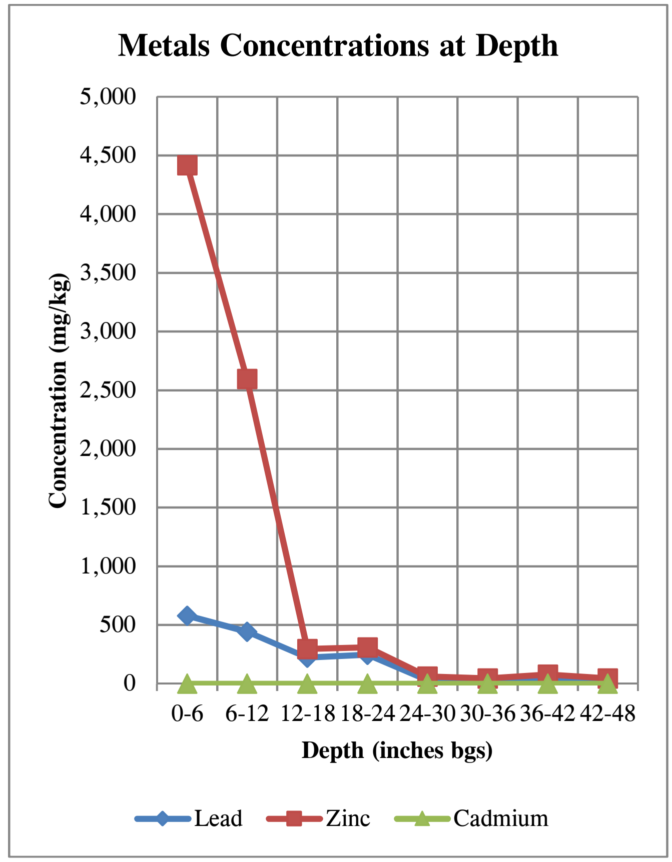
Test Pit 15A

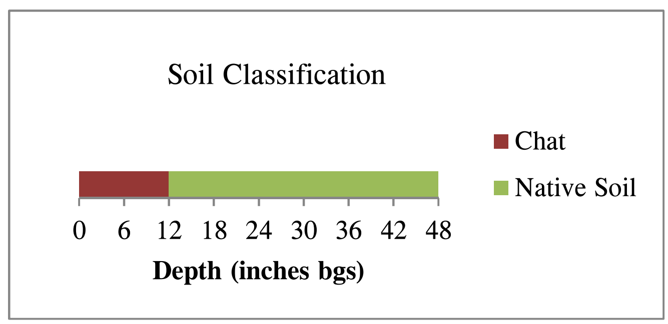




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**328**	**1,972**	< 13.6
6-12	**244**	**1,249**	**< 11.2**
12-18	**95**	**828**	**< 11.6**
18-24	**62**	**536**	**< 11.8**
24-30	**10**	**122**	< 12.7
30-36	**16**	**255**	< 14.9
36-42	**< 10.1**	**29**	< 12.8
42-48	**< 8.8**	**18**	< 12.6

Test Pit 15B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**579**	**4,418**	< 12.3
6-12	**443**	**2,597**	< 13.6
12-18	**222**	**295**	< 12.9
18-24	**247**	**310**	< 13.8
24-30	**27**	**61**	< 12.0
30-36	**11**	**45**	< 13.9
36-42	**47**	**78**	< 14.8
42-48	**14**	**45**	< 13.0

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

[grey box] - Above Residential RSL

bgs - below ground surface

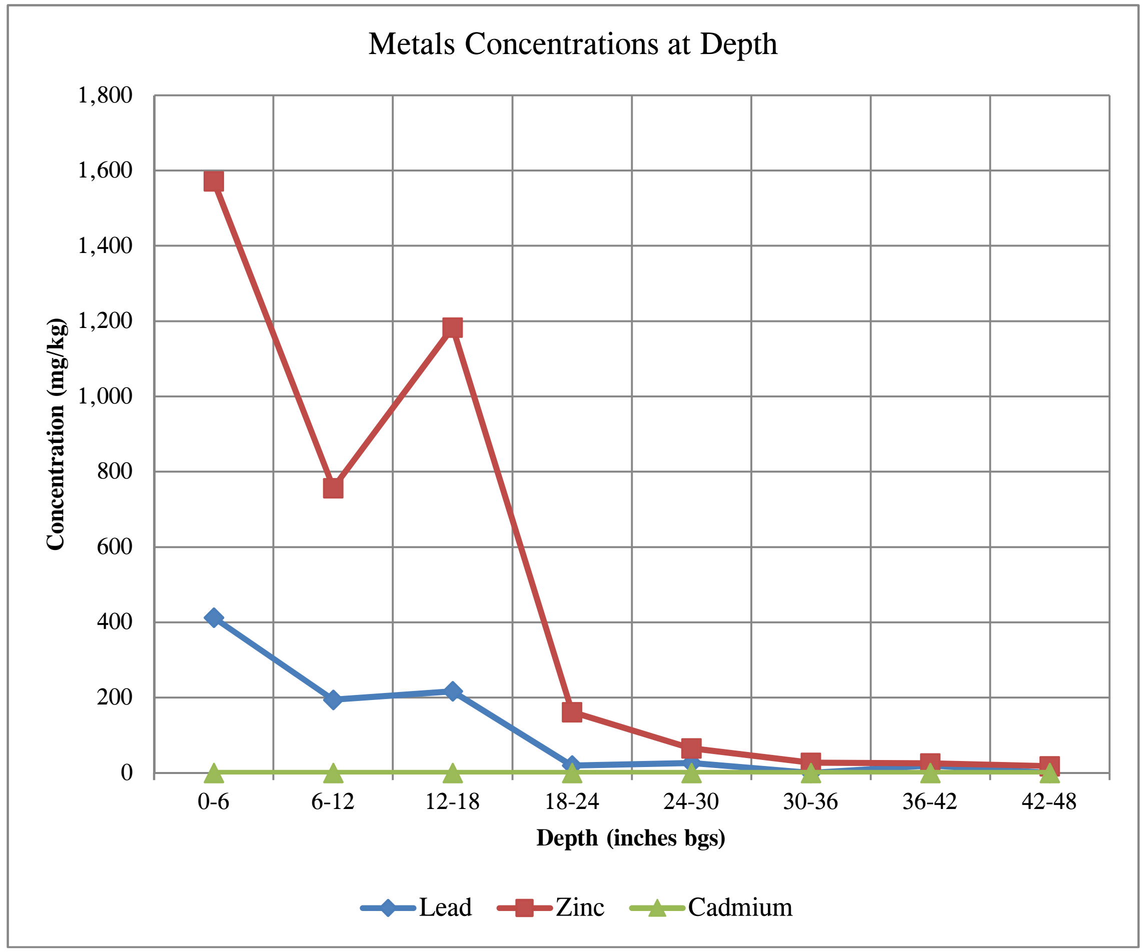
mg/kg - milligrams per kilogram

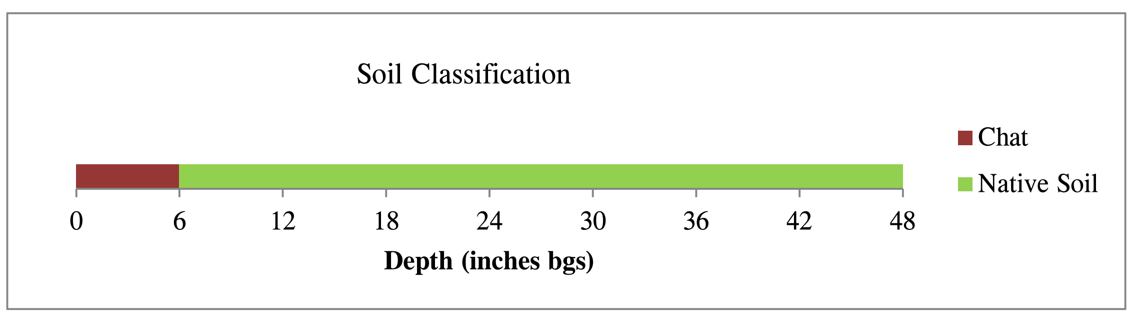
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.16
Metals Concentrations at Depth - Location 16
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

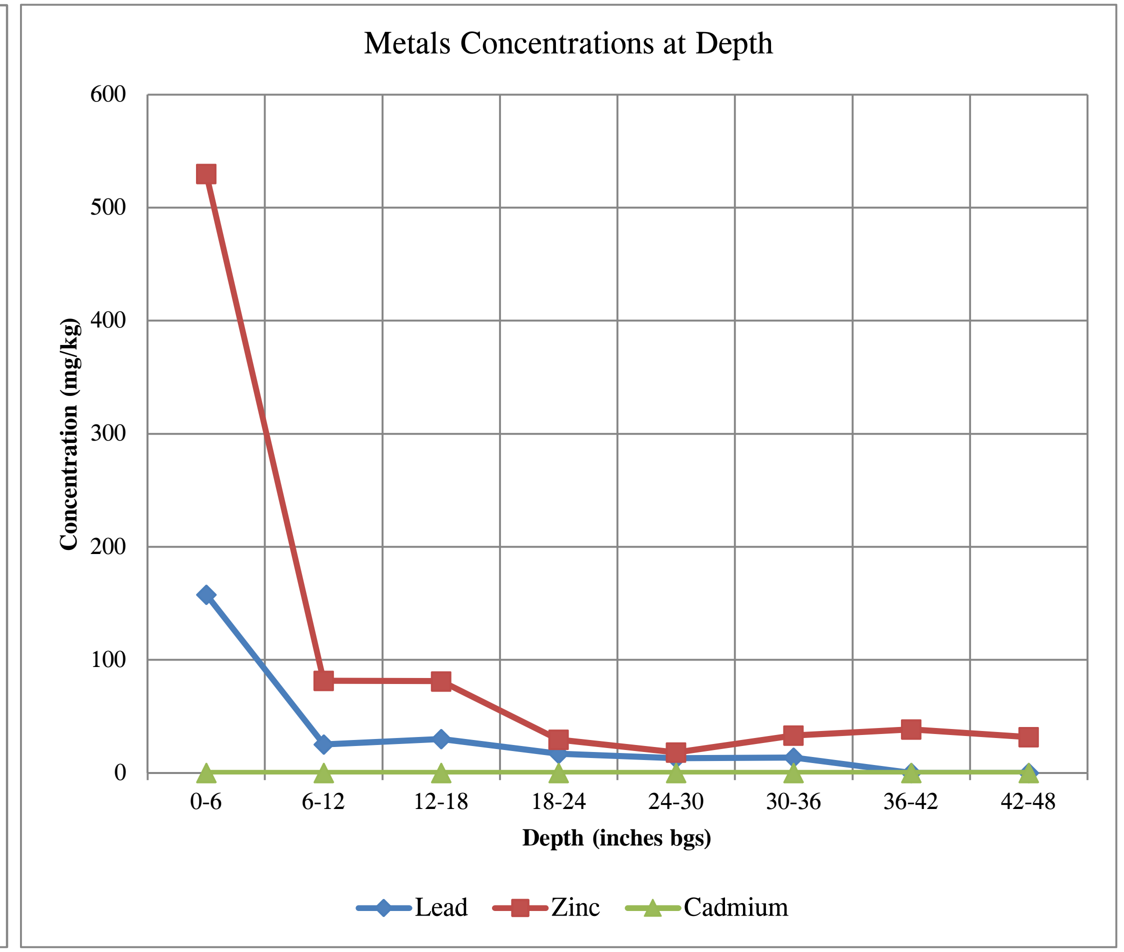
Test Pit 16A

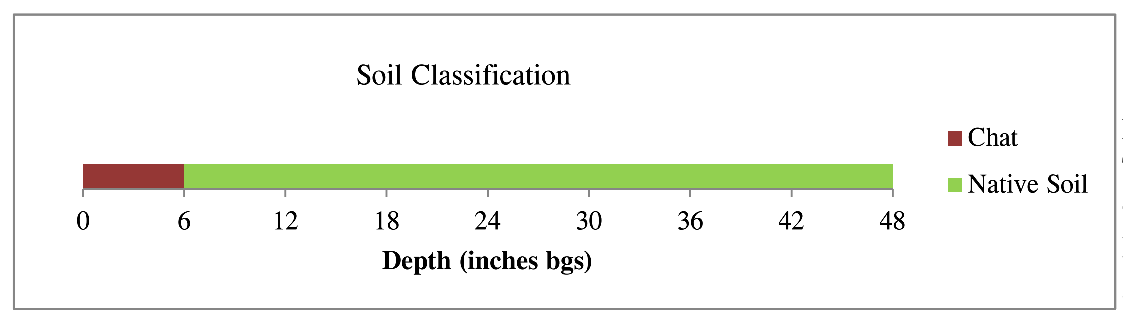




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**412**	**1,572**	< 12.3
6-12	**194**	**757**	< 11.7
12-18	**217**	**1,183**	< 13.1
18-24	**19**	**162**	< 12.1
24-30	**26**	**65**	< 15.2
30-36	< 11.3	**27**	< 12.7
36-42	**20**	**25**	< 12.7
42-48	< 10.2	**18**	< 12.6

Test Pit 16B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**158**	**530**	< 12.3
6-12	**25**	**81**	< 12.7
12-18	**30**	**81**	< 12.8
18-24	**17**	**29**	< 11.9
24-30	**13**	**18**	< 12
30-36	**14**	**33**	< 13.6
36-42	< 16.5	**38**	< 12.4
42-48	< 10.2	**32**	< 12.9

Test Pit 16A-E

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**70**	**383**	< 12.5

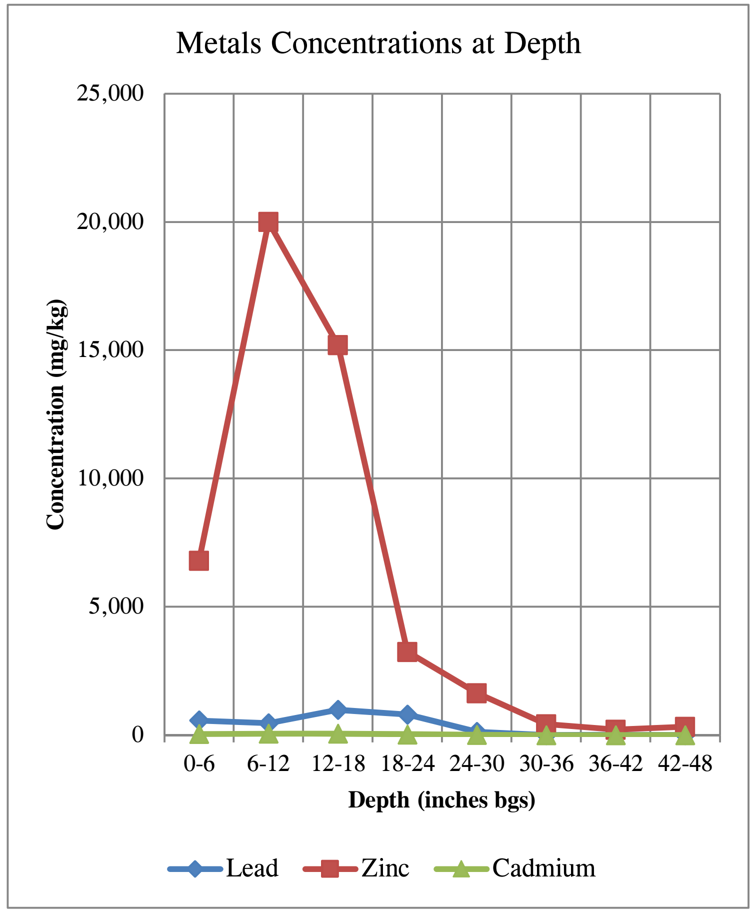
Metals concentration graphs and soil classification profiles are not shown for test pits at which lead concentrations were below the Regional Screening Levels for lead.

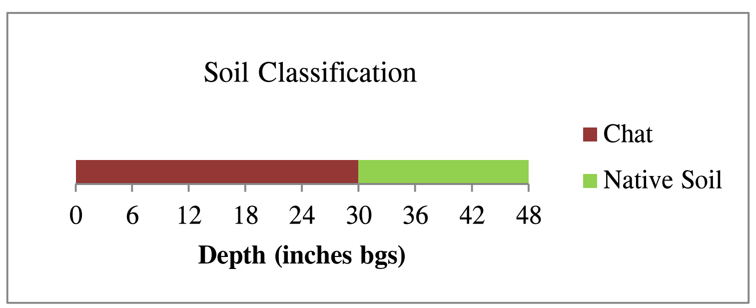
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.17
Metals Concentrations at Depth - Location 17
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

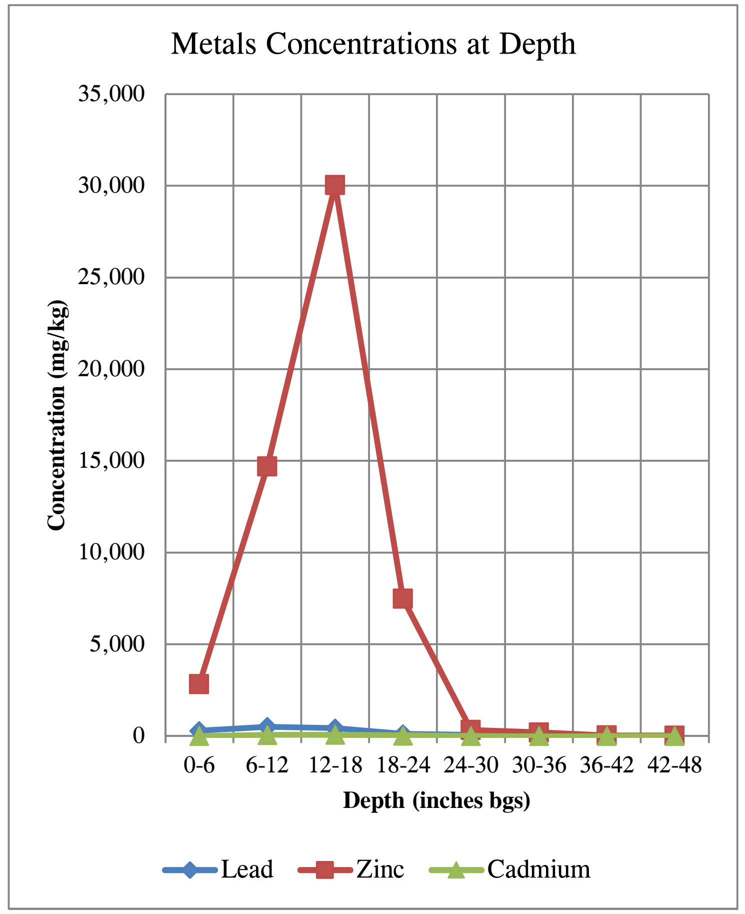
Test Pit 17A

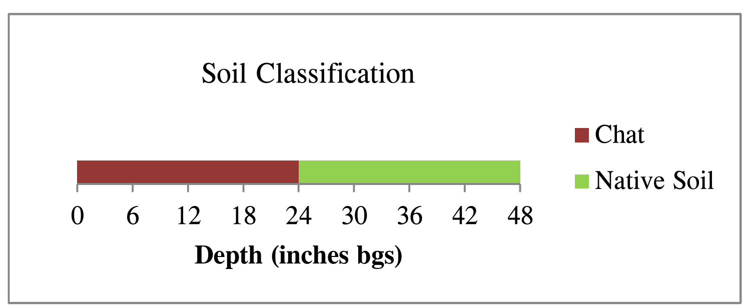




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**570**	**6,795**	**44**
6-12	**463**	**20,000**	**59**
12-18	**987**	**15,200**	**60**
18-24	**800**	**3,248**	**29**
24-30	**127**	**1,640**	**17**
30-36	< 12.4	**427**	< 12.5
36-42	**18**	**218**	< 14.8
42-48	< 14.0	**325**	< 13.9

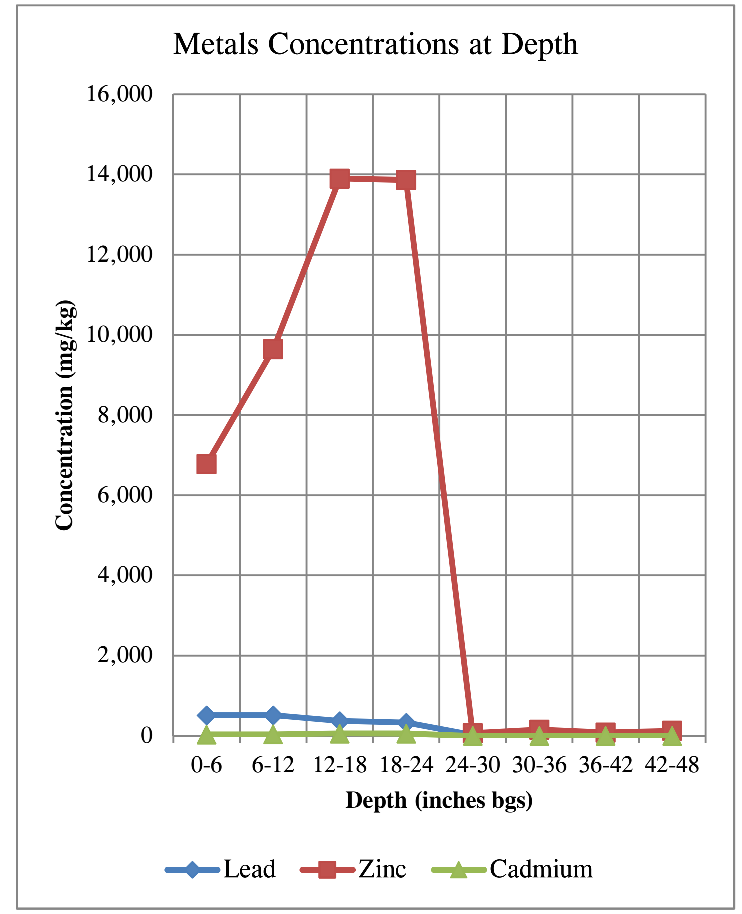
Test Pit 17B

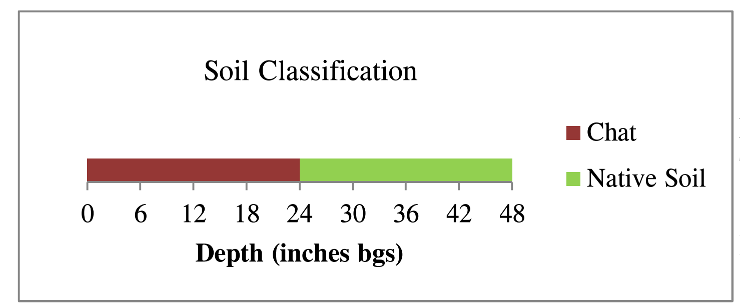




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**281**	**2,829**	< 12.8
6-12	**506**	**14,700**	**54**
12-18	**422**	**30,050**	**72**
18-24	**115**	**7,499**	**29**
24-30	**56**	**329**	< 12.8
30-36	< 11.1	**198**	< 11.7
36-42	< 14.8	**32**	< 14.2
42-48	< 13.1	**26**	< 12.5

Test Pit 17C





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**515**	**6,781**	**34**
6-12	**516**	**9,644**	**39**
12-18	**371**	**13,900**	**56**
18-24	**329**	**13,867**	**57**
24-30	**18**	**66**	< 12.8
30-36	**15**	**158**	< 11.6
36-42	< 15.9	**83**	< 12.9
42-48	**22**	**126**	< 13.8

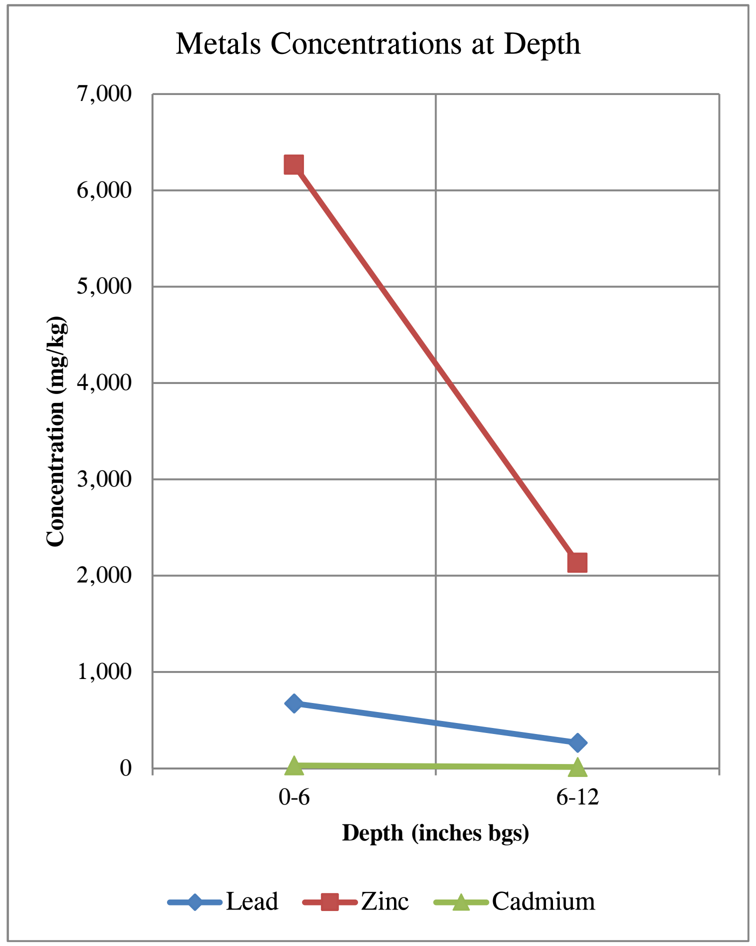
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

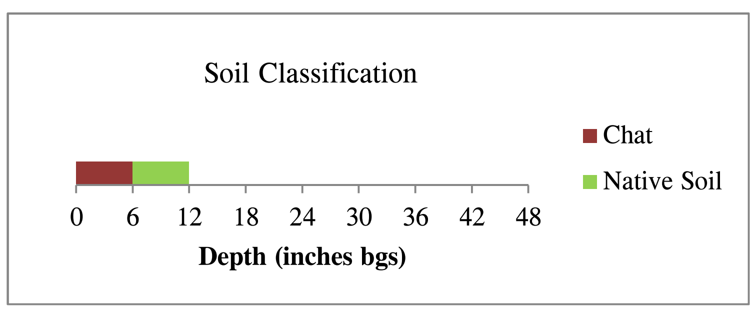
- Above Regional Screening Level

bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.17 (Continued)
Metals Concentrations at Depth - Location 17
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

Test Pit 17B-S





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**676**	**6,267**	**28**
6-12	**264**	**2,132**	**14**

Test Pit 17B-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	< 14.1	**55**	**16**

Test Pit 17B-S2

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**89**	**718**	< 12.3

Metals concentration graphs and boring log profiles are not shown for test pits at which lead concentrations were below the Regional Screening Levels for lead.

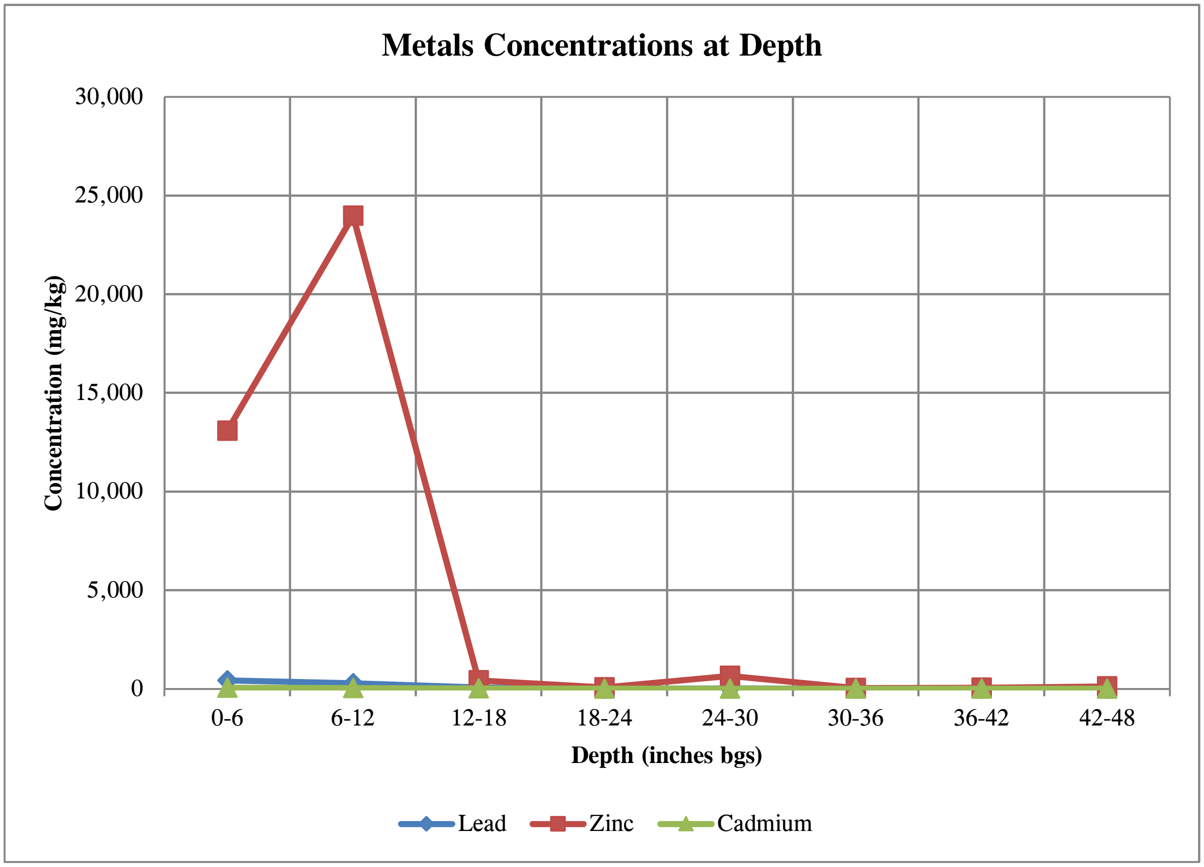
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

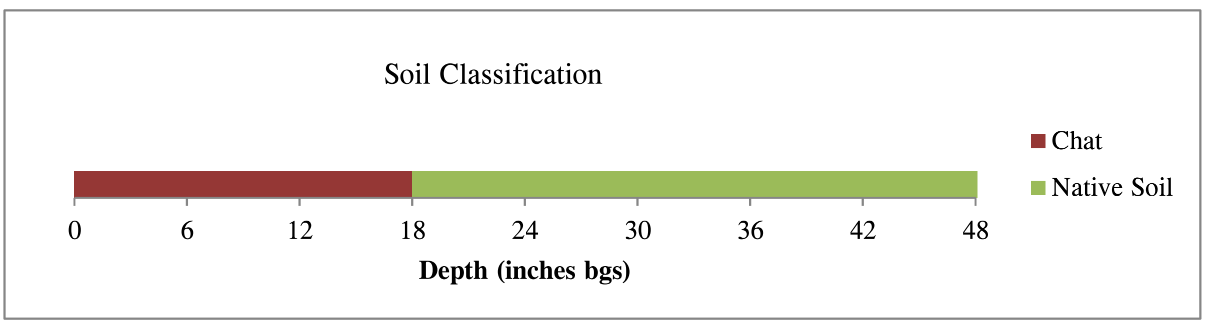
(gray box) - Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram

Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.18
Metals Concentrations at Depth - Location 18
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Test Pit 18A



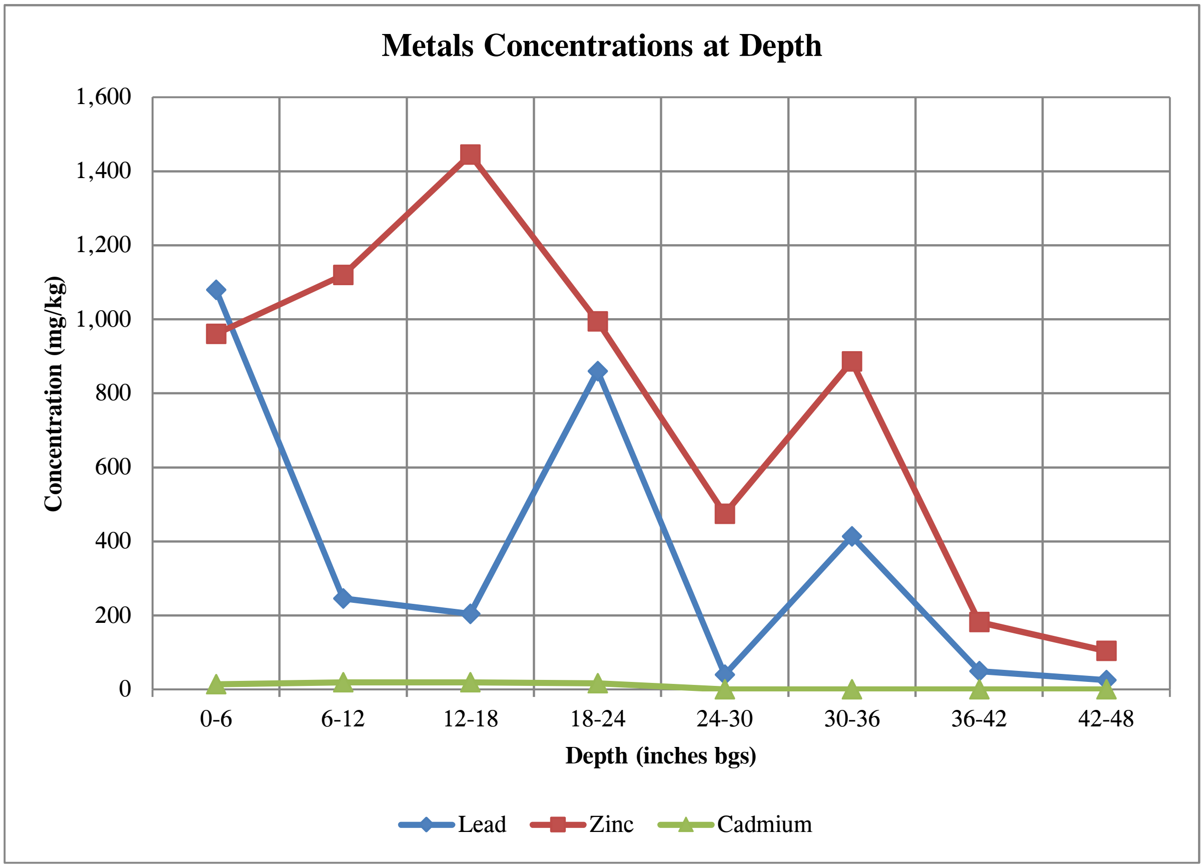


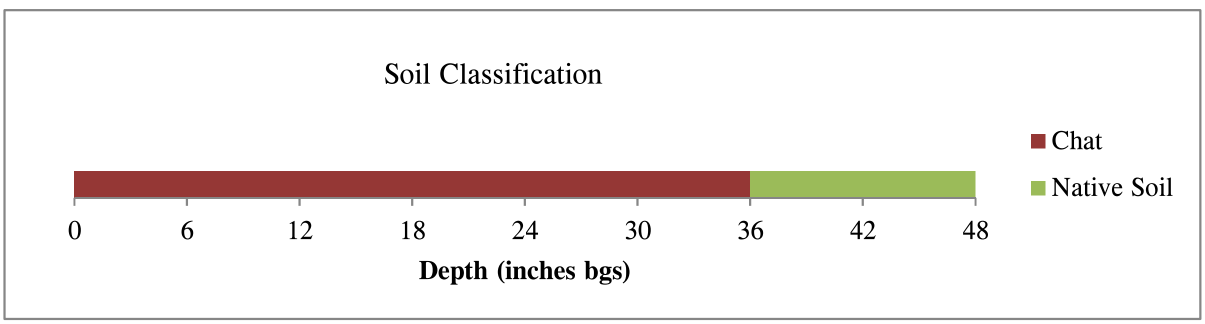
Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**421**	**13,075**	**52**
6-12	**281**	**23,967**	**37**
12-18	**63**	**425**	**16**
18-24	<13.5	**63**	<13.5
24-30	**18**	**647**	<12.0
30-36	<11.4	**35**	<11.9
36-42	<11.8	**59**	<13.2
42-48	<12.7	**117**	<13.3

- Above Residential RSL
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.19
Metals Concentrations at Depth - Location 19
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Test Pit 19A





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**1,079**	**960**	**15**
6-12	**246**	**1,120**	**20**
12-18	**204**	**1,444**	**19**
18-24	**860**	**994**	**17**
24-30	**40**	**474**	< 14
30-36	**413**	**886**	< 12.5
36-42	**49**	**182**	< 13.6
42-48	**25**	**104**	< 13.7

- Above Residential RSL

bgs - below ground surface

mg/kg - milligrams per kilogram

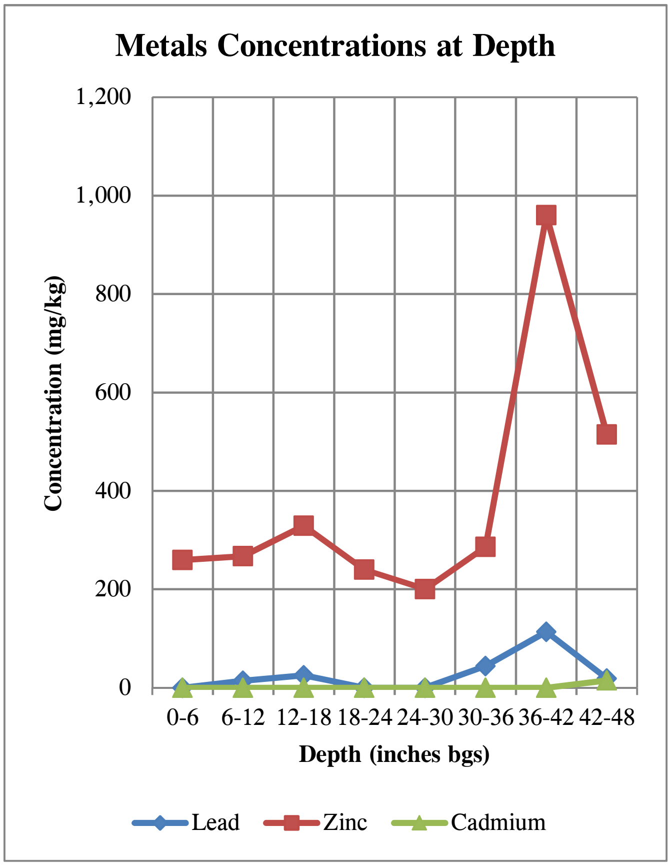
Bold - Detection

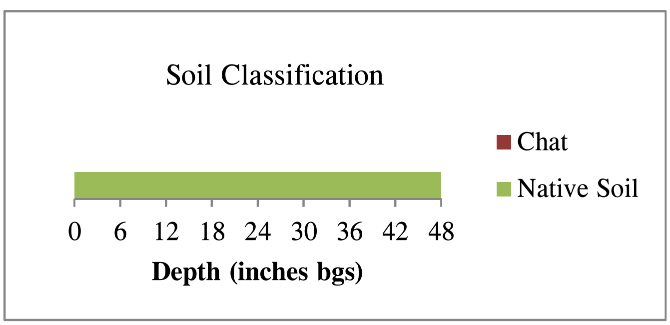
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

Figure 5.20
Metals Concentrations at Depth - Location 20
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

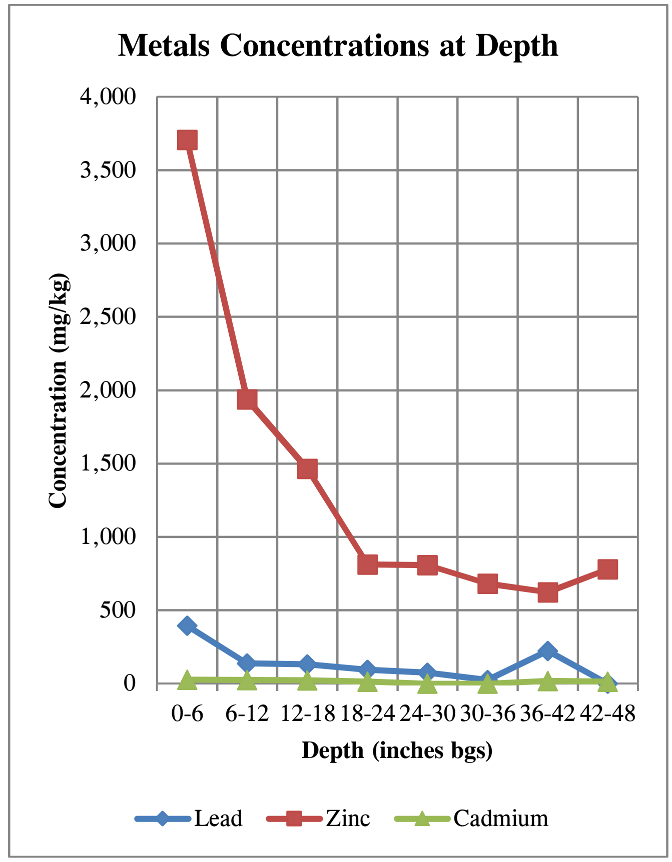
Test Pit 20A

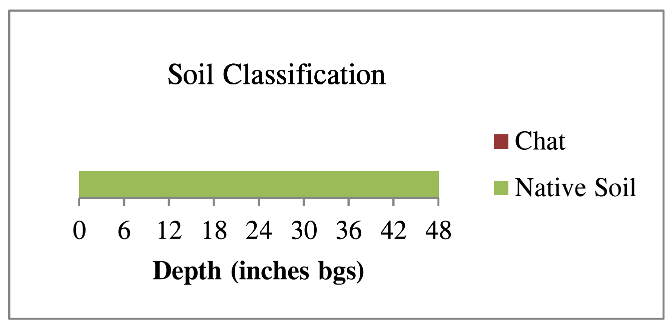




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	<14.1	**260**	<13.1
6-12	**14**	**267**	<12.1
12-18	**25**	**329**	<13.8
18-24	<13.1	**240**	<12.7
24-30	<12.2	**200**	<11.8
30-36	**44**	**286**	<13.8
36-42	**114**	**960**	<12.5
42-48	**19**	**515**	**15**

Test Pit 20B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**395**	**3,706**	**27**
6-12	**138**	**1,939**	**24**
12-18	**131**	**1,464**	**22**
18-24	**94**	**813**	**14**
24-30	**75**	**809**	<12.1
30-36	**24**	**682**	<11.9
36-42	**223**	**623**	**18**
42-48	<13.4	**781**	**13**

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

- Above Residential RSL

bgs - below ground surface

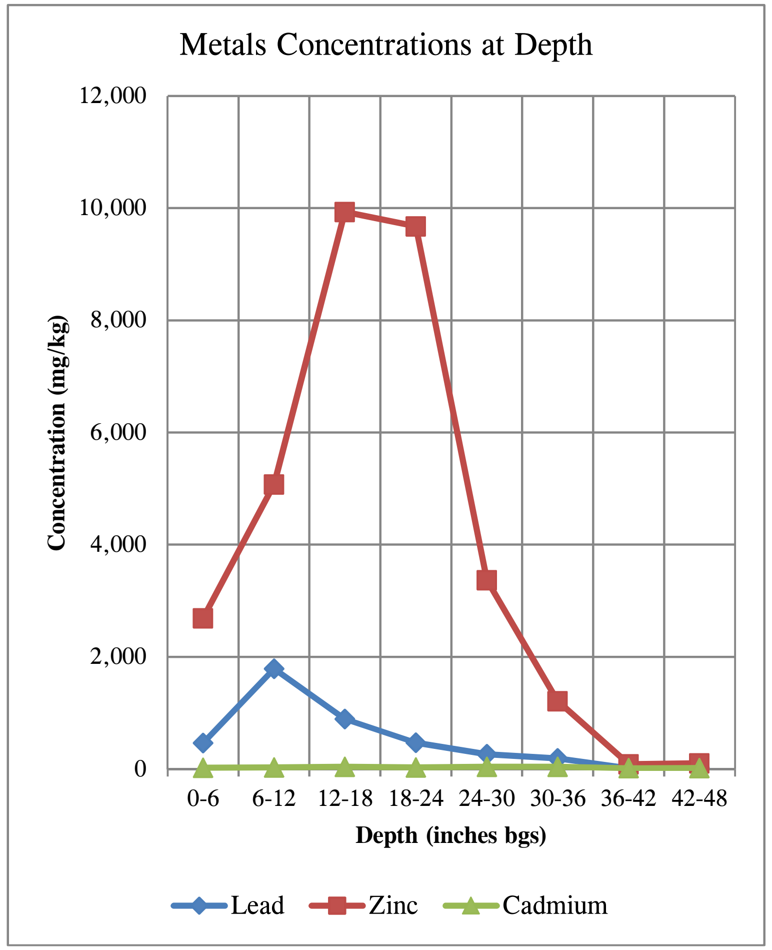
mg/kg - milligrams per kilogram

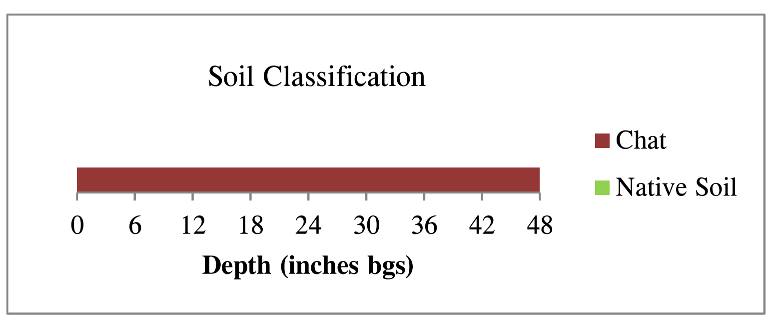
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.21
Metals Concentrations at Depth - Location 21
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

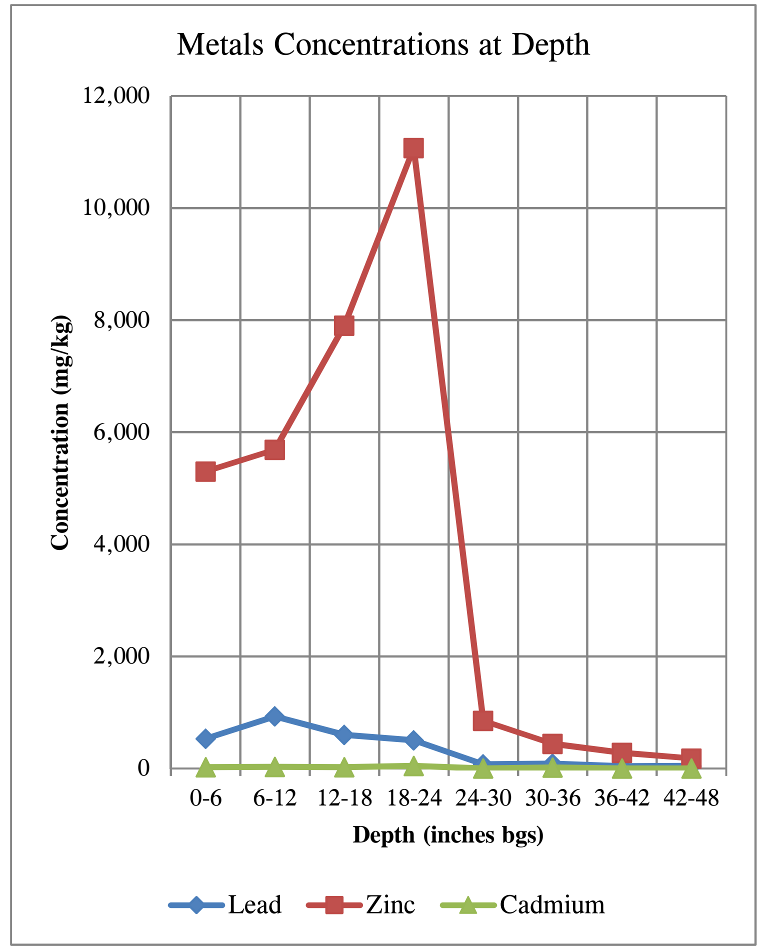
Test Pit 21A

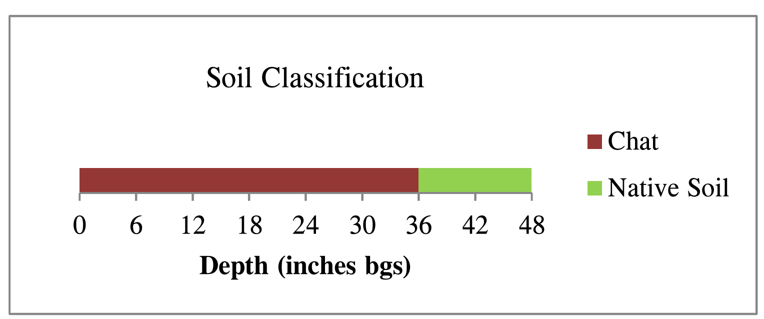




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**461**	**2,690**	**21**
6-12	**1,785**	**5,078**	**29**
12-18	**889**	**9,934**	**41**
18-24	**471**	**9,678**	**27**
24-30	**262**	**3,367**	**39**
30-36	**190**	**1,210**	**40**
36-42	**16**	**86**	**15**
42-48	**27**	**104**	**19**

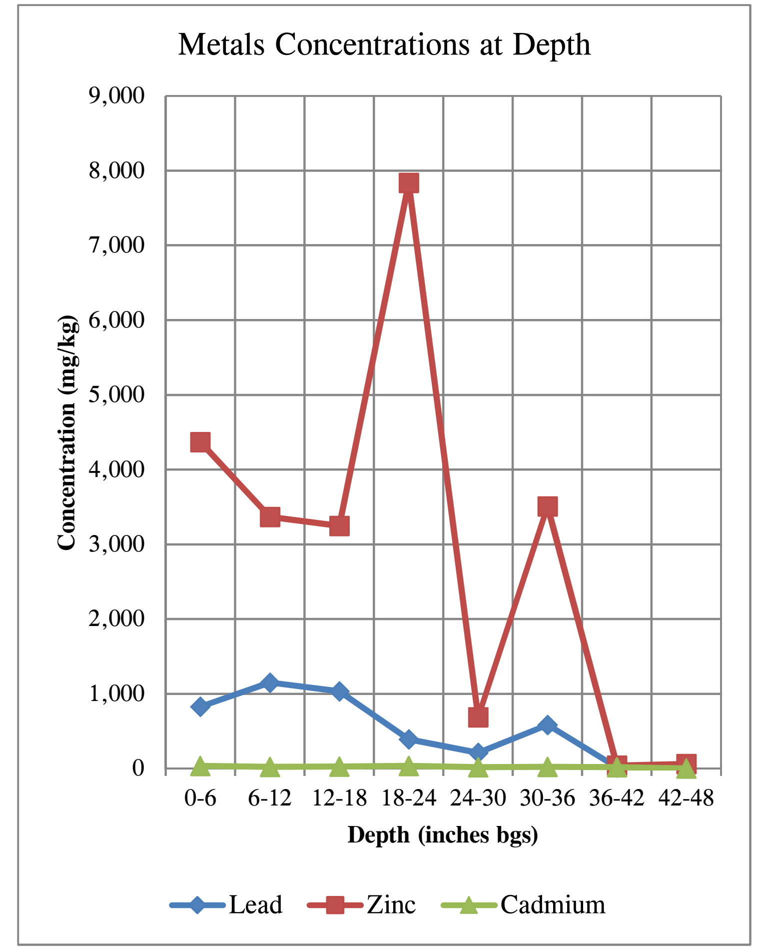
Test Pit 21B

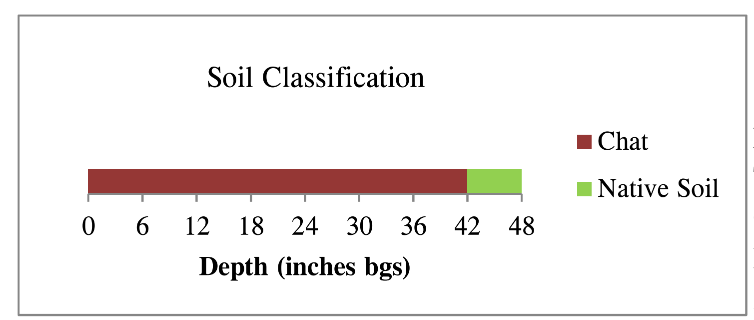




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**534**	**5,298**	**24**
6-12	**930**	**5,687**	**28**
12-18	**600**	**7,905**	**25**
18-24	**501**	**11,069**	**47**
24-30	**76**	**852**	< 12.9
30-36	**86**	**439**	**18**
36-42	**43**	**282**	< 12.4
42-48	**46**	**181**	< 13.9

Test Pit 21C





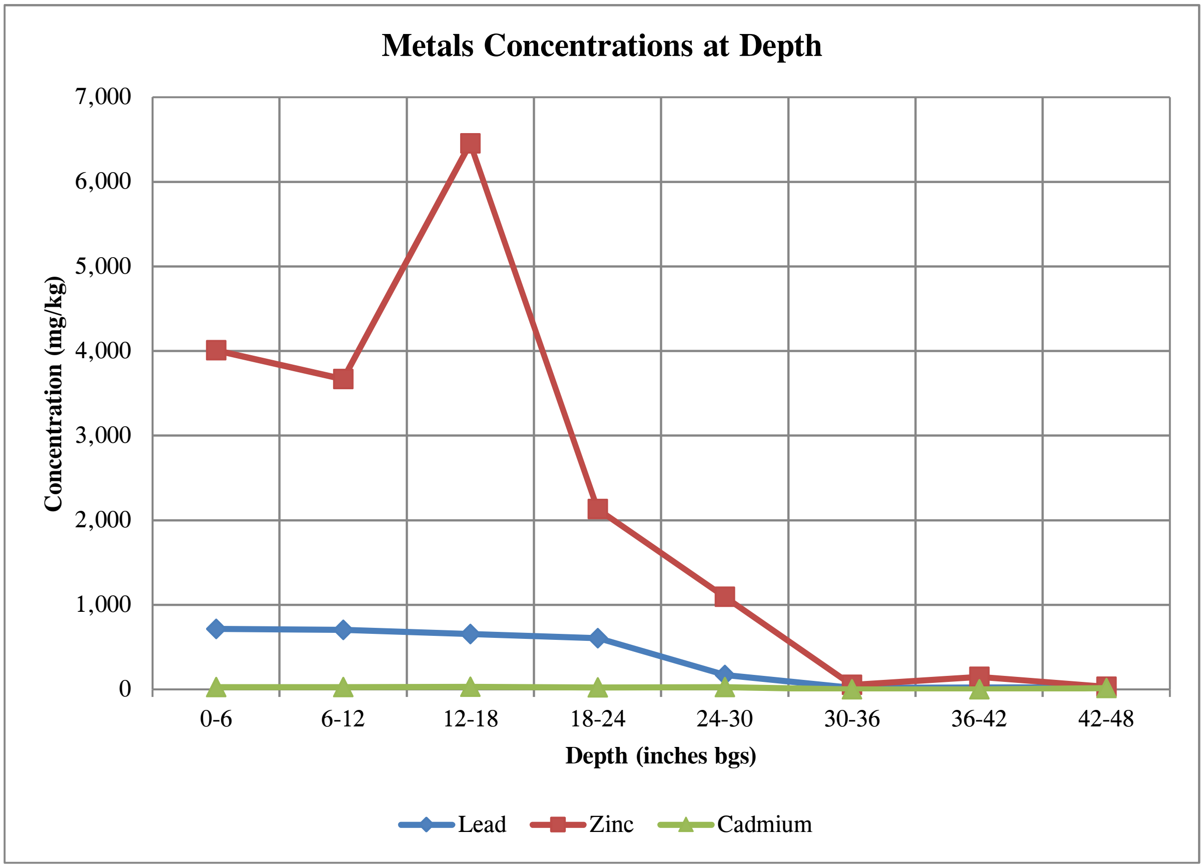
Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**829**	**4,368**	**36**
6-12	**1,151**	**3,367**	**22**
12-18	**1,031**	**3,248**	**28**
18-24	**390**	**7,836**	**34**
24-30	**212**	**686**	**18**
30-36	**583**	**3,510**	**21**
36-42	**16**	**41**	**19**
42-48	**18**	**59**	< 11.5

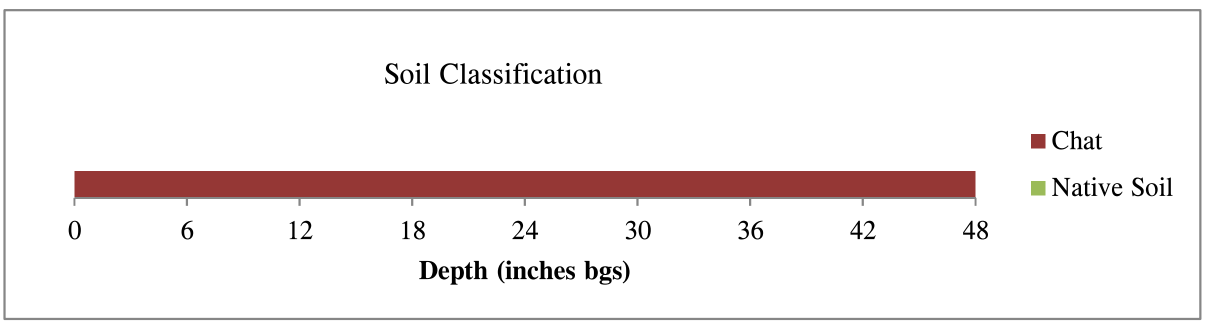
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.22
Metals Concentrations at Depth - Location 22
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

Test Pit 22A



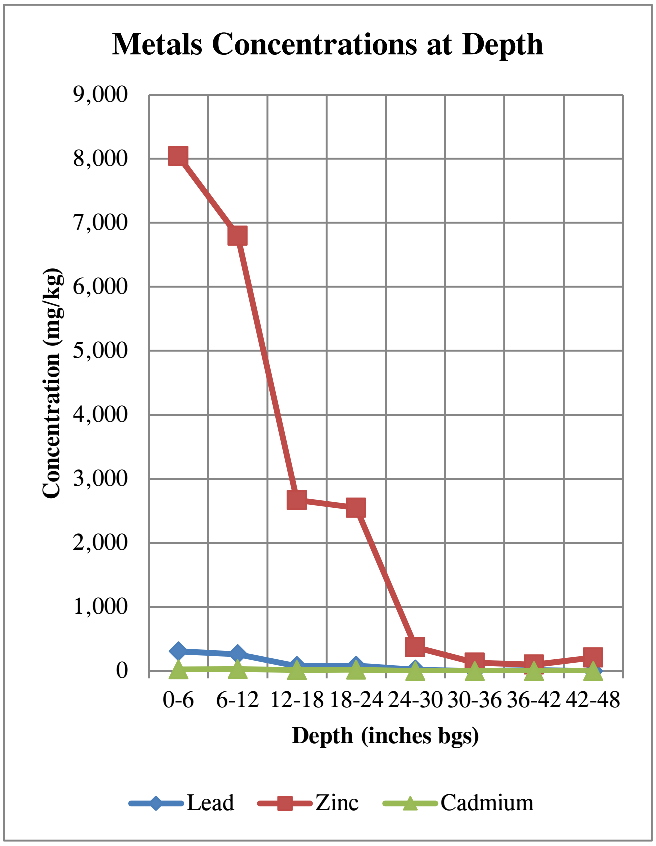


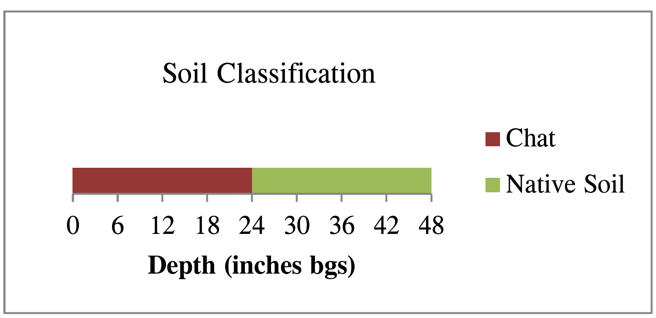
Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**716**	**4,007**	**27**
6-12	**707**	**3,666**	**27**
12-18	**655**	**6,454**	**32**
18-24	**608**	**2,131**	**24**
24-30	**173**	**1,095**	**26**
30-36	**21**	**53**	<14.7
36-42	**25**	**147**	<19.2
42-48	**26**	**33**	**17**

- Above Residential RSL
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

Figure 5.23
Metals Concentrations at Depth - Location 23
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

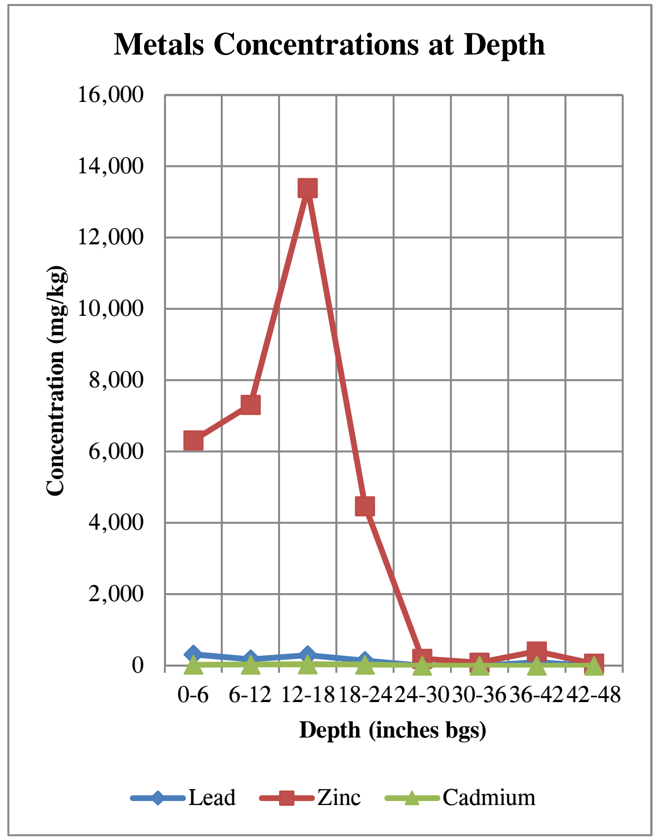
Test Pit 23A

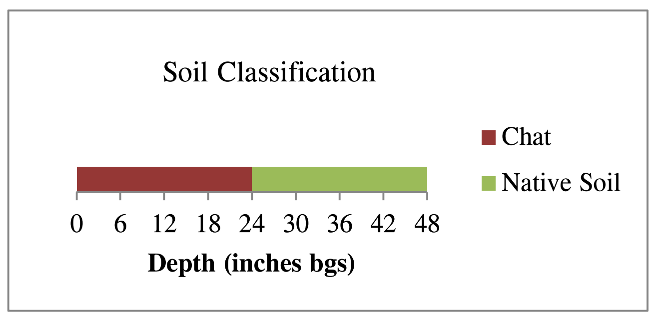




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**309**	**8,039**	**23**
6-12	**261**	**6,797**	**30**
12-18	**76**	**2,669**	**16**
18-24	**84**	**2,550**	**18**
24-30	**21**	**368**	< 11.7
30-36	< 11.4	**130**	< 11.2
36-42	**16**	**98**	< 12.3
42-48	< 11.7	**208**	< 11.6

Test Pit 23B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**317**	**6,314**	**25**
6-12	**177**	**7,310**	**29**
12-18	**295**	**13,392**	**39**
18-24	**136**	**4,471**	**30**
24-30	< 11.7	**191**	< 11.2
30-36	< 11.7	**86**	< 11.5
36-42	**95**	**397**	< 11.3
42-48	< 13.0	**53**	< 15.7

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

[grey box] - Above Residential RSL

bgs - below ground surface

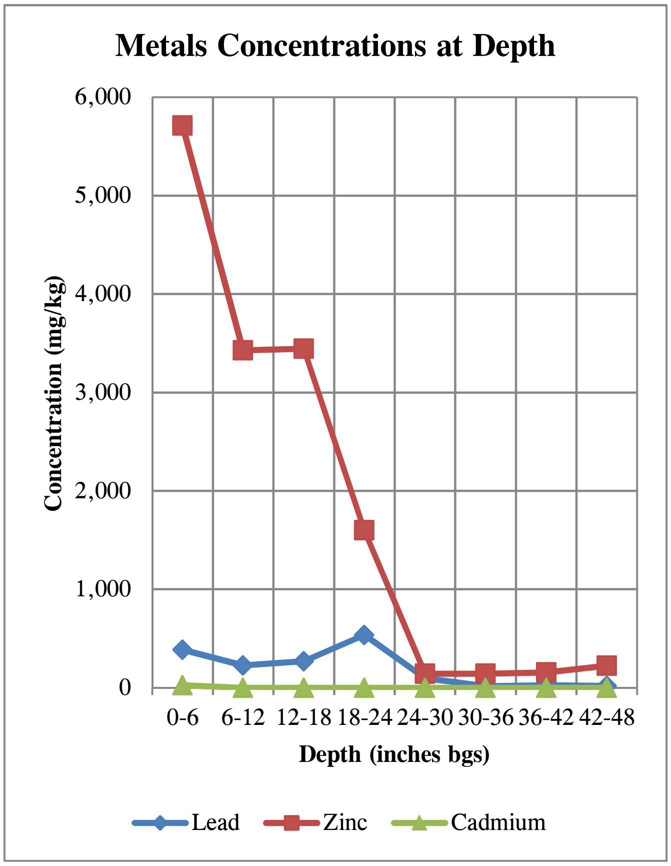
mg/kg - milligrams per kilogram

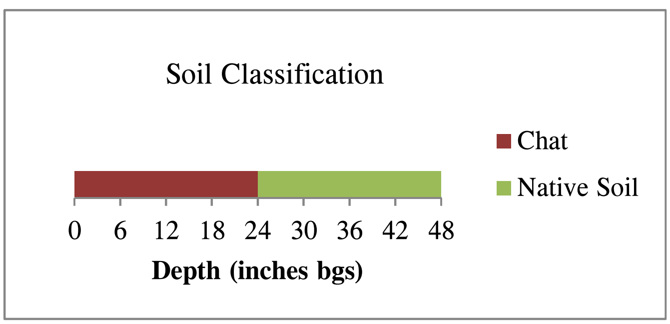
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.24
Metals Concentrations at Depth - Location 24
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

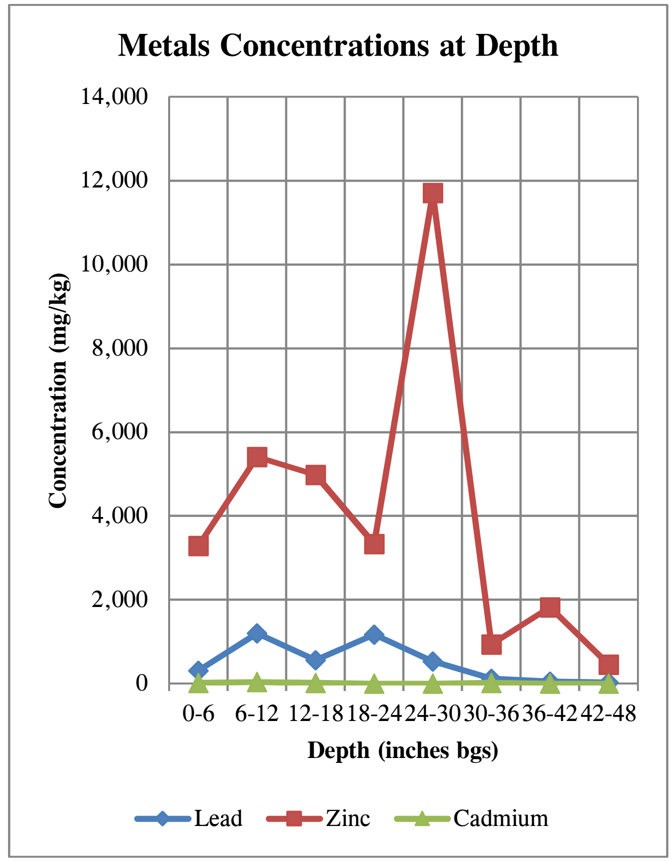
Test Pit 24A

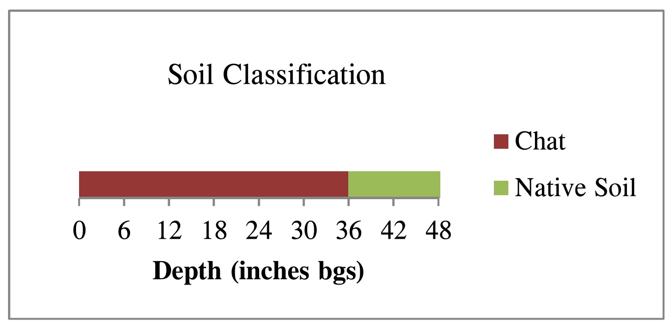




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**388**	**5,711**	**26**
6-12	**226**	**3,429**	< 14.9
12-18	**270**	**3,443**	< 11.0
18-24	**537**	**1,600**	< 13.6
24-30	**98**	**143**	< 13.9
30-36	**17**	**142**	< 13.4
36-42	**26**	**155**	< 12.5
42-48	**19**	**222**	< 13.6

Test Pit 24B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**310**	**3,286**	**17**
6-12	**1,199**	**5,406**	**38**
12-18	**558**	**4,977**	**18**
18-24	**1,170**	**3,332**	< 13.0
24-30	**530**	**11,707**	< 10.4
30-36	**115**	**938**	**18**
36-42	**51**	**1,821**	< 12.6
42-48	**26**	**457**	< 11.9

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

- Above Residential RSL

bgs - below ground surface

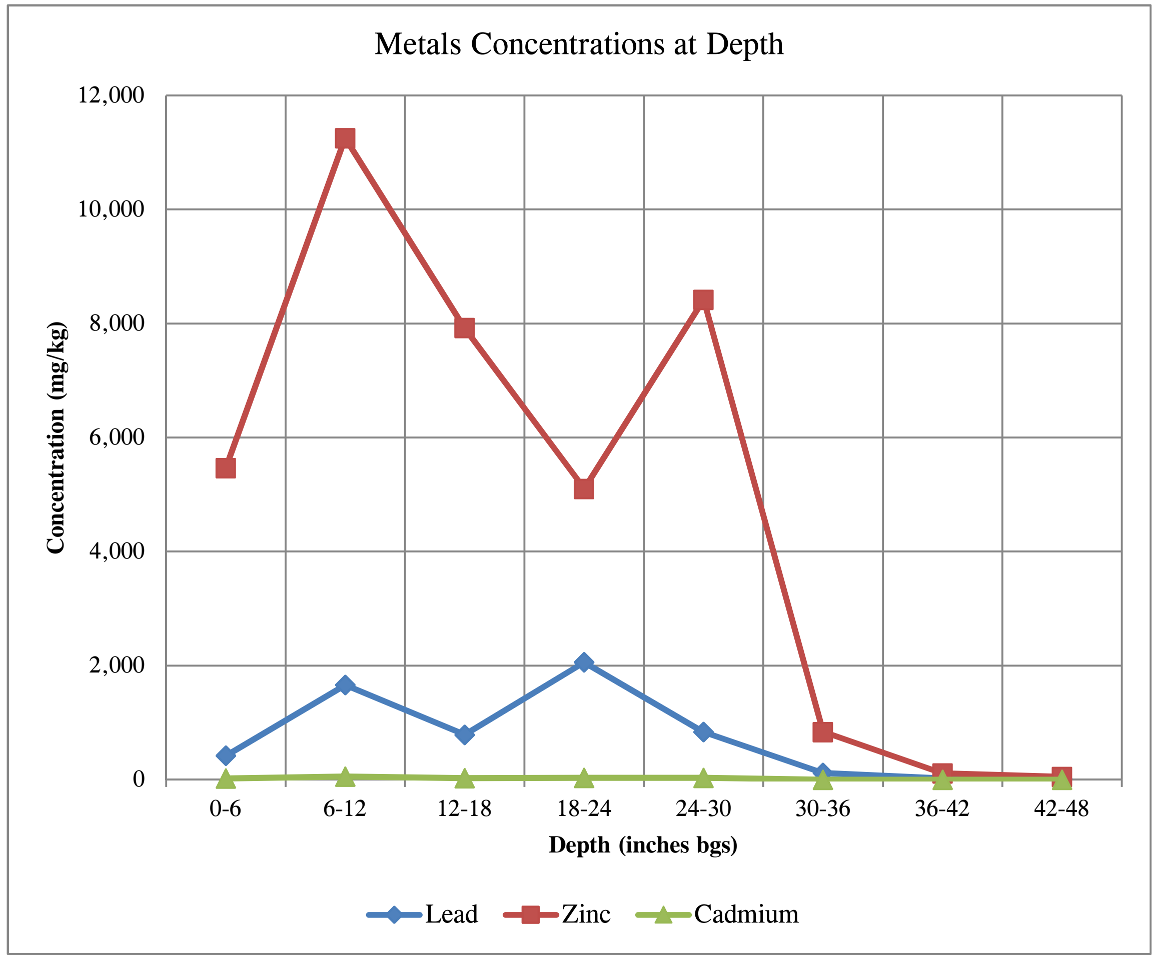
mg/kg - milligrams per kilogram

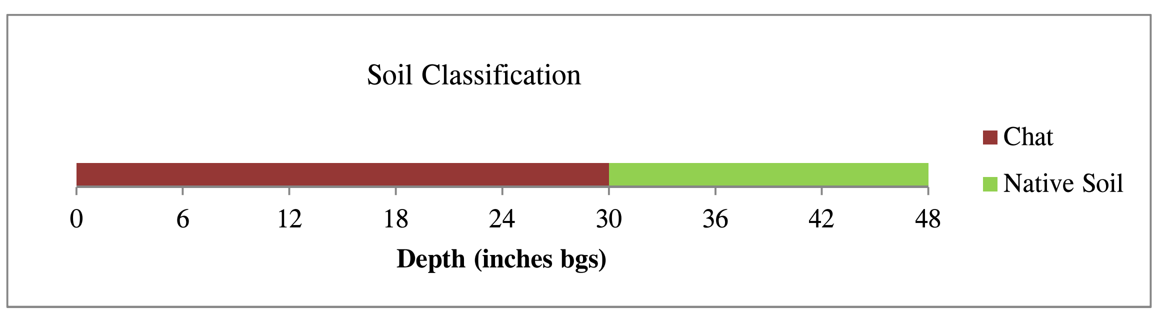
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.25
Metals Concentrations at Depth - Location 25
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

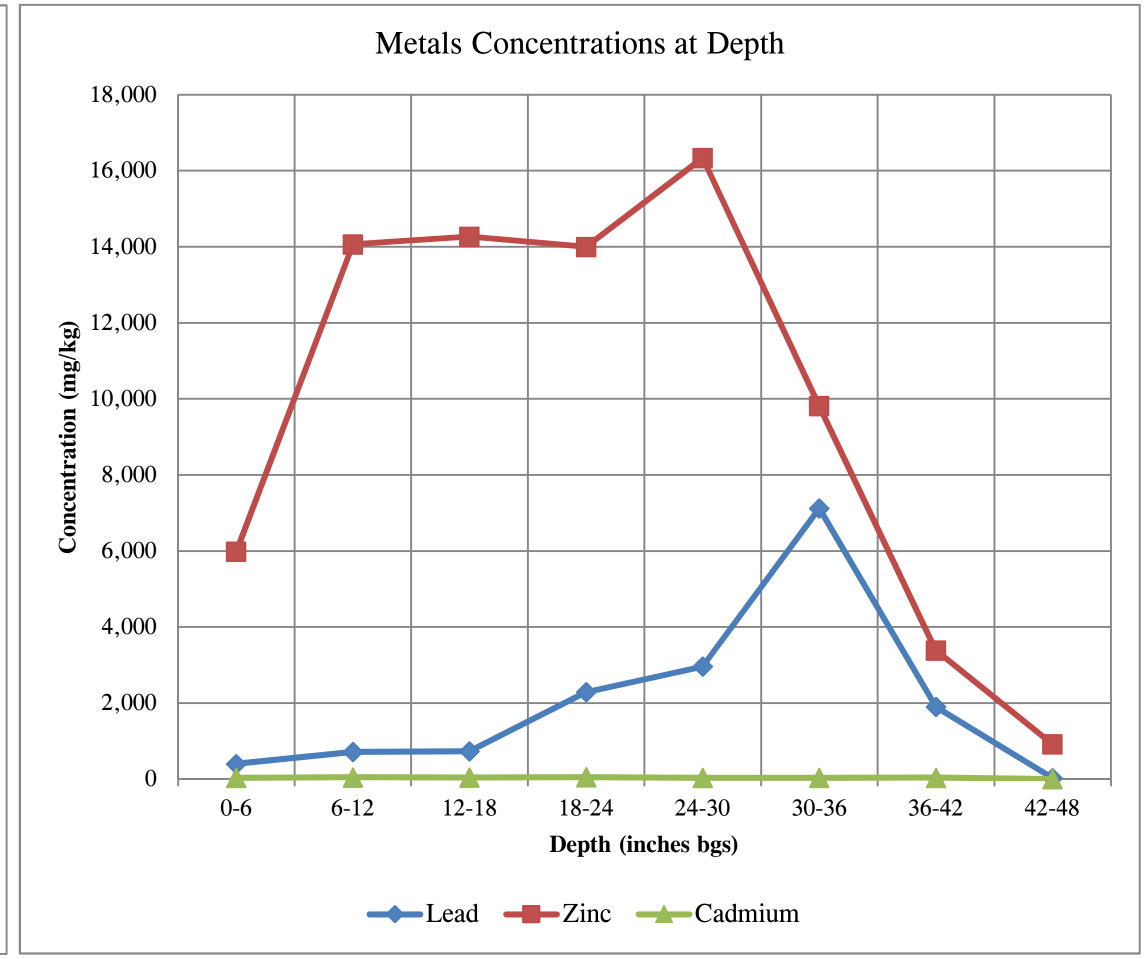
Test Pit 25A

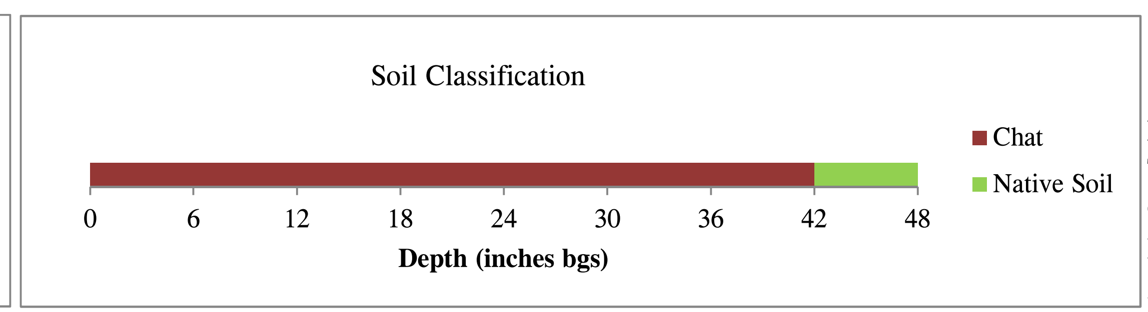




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**420**	**5,463**	**21**
6-12	**1,657**	**11,251**	**52**
12-18	**785**	**7,921**	**25**
18-24	**2,057**	**5,101**	**29**
24-30	**832**	**8,416**	**33**
30-36	**115**	**836**	< 12.9
36-42	**22**	**110**	< 12.3
42-48	**12**	**50**	< 13.3

Test Pit 25B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**397**	**5,988**	**32**
6-12	**714**	**14,067**	**44**
12-18	**729**	**14,267**	**38**
18-24	**2,285**	**14,000**	**50**
24-30	**2,957**	**16,340**	**31**
30-36	**7,117**	**9,810**	**31**
36-42	**1,902**	**3,385**	**35**
42-48	**25**	**916**	< 13.2

Test Pit 25A-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**239**	**2,085**	< 12.9
6-12	**164**	**1,335**	< 13.1

Test Pit 25A-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**129**	**1,080**	< 12.5
6-12	**61**	**342**	< 12.8

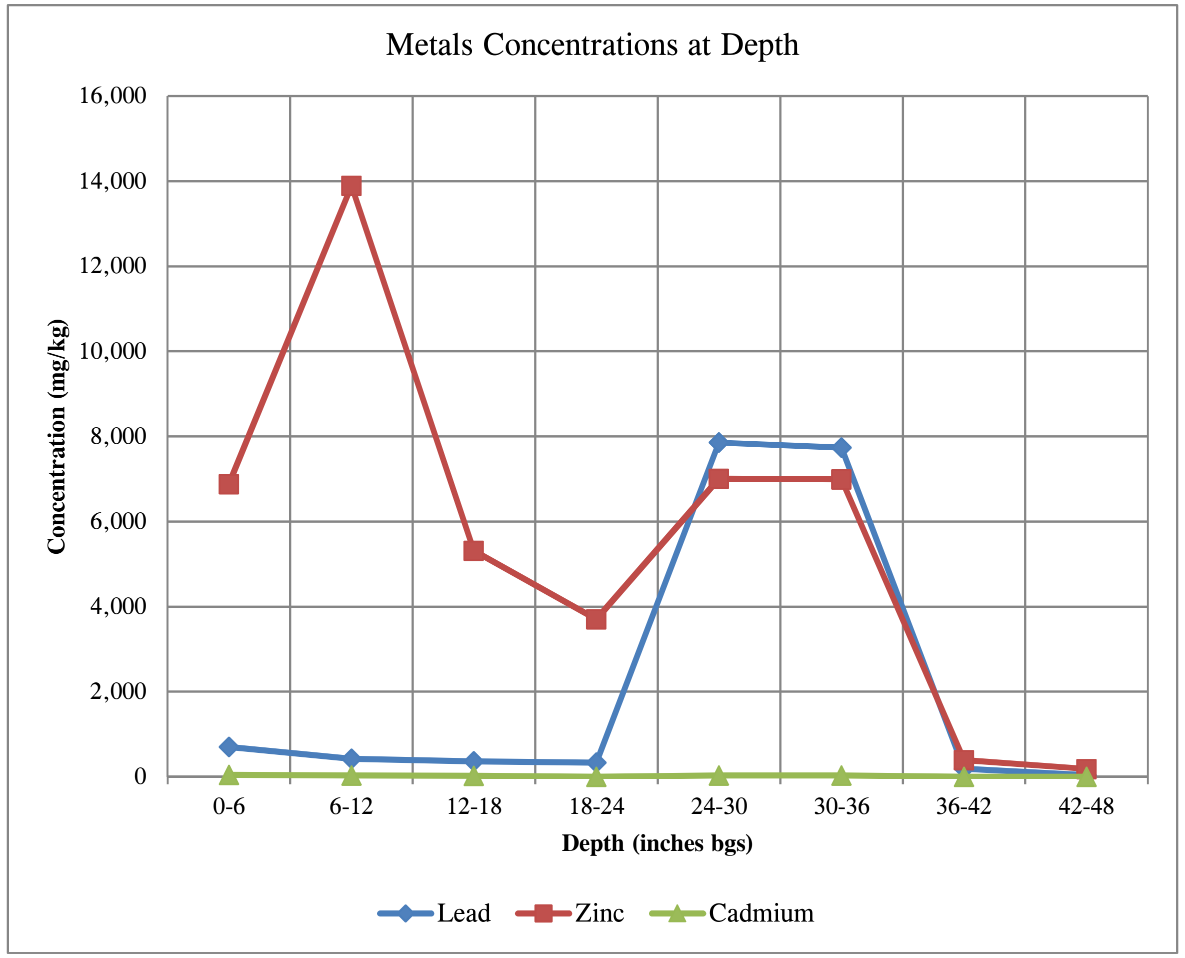
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

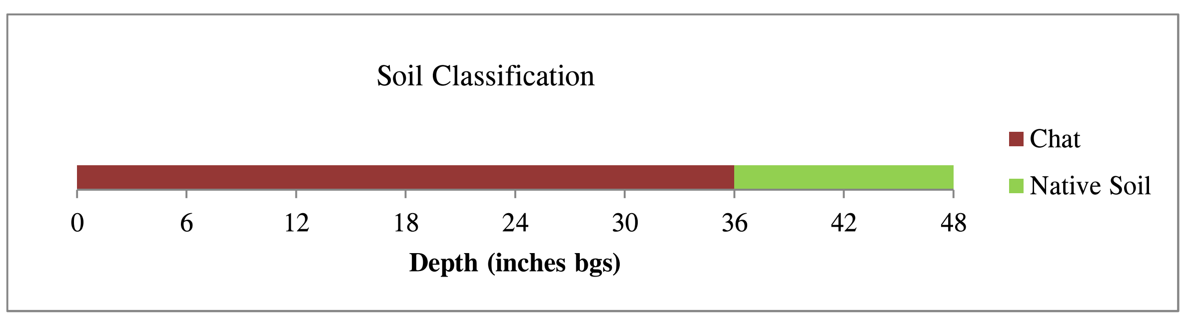
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.26
Metals Concentrations at Depth - Location 26
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

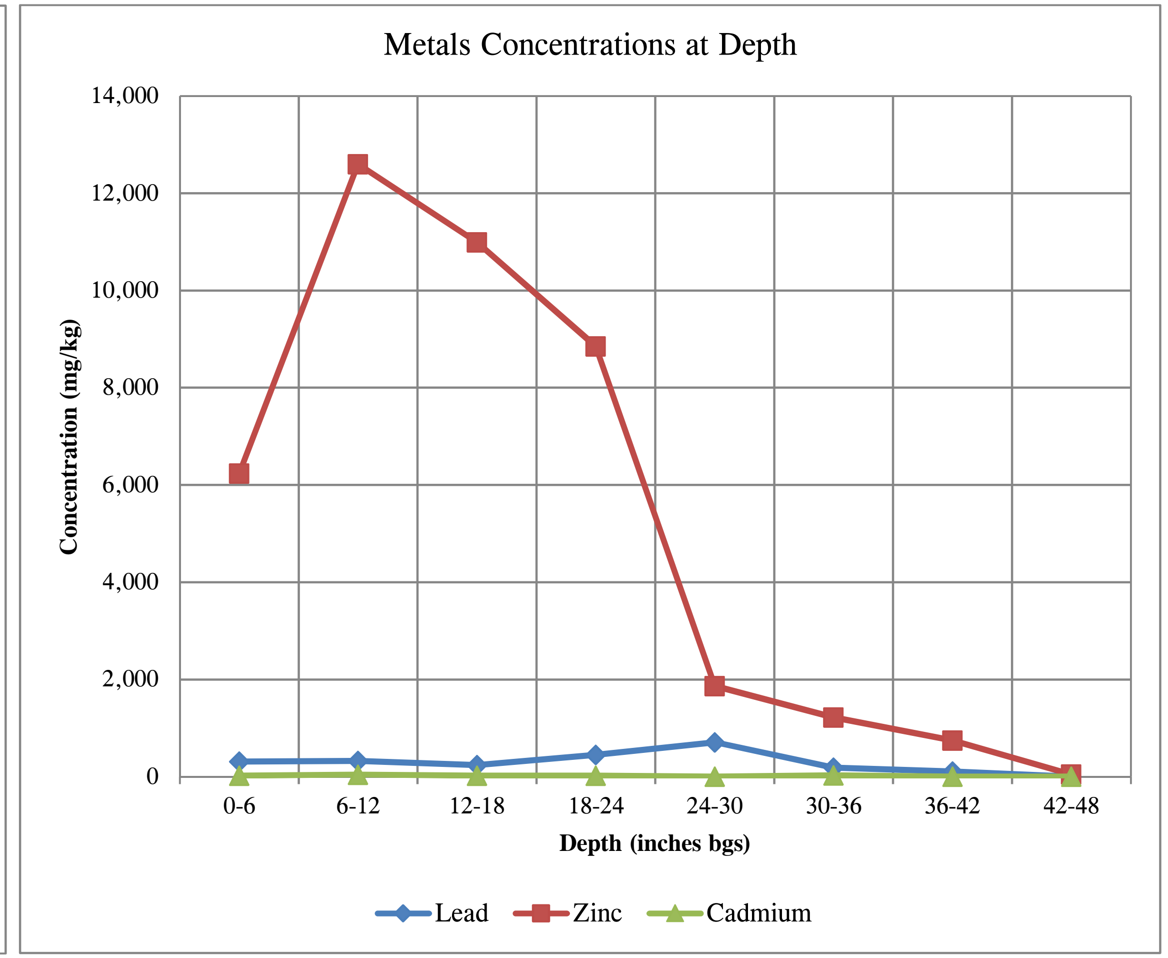
Test Pit 26A

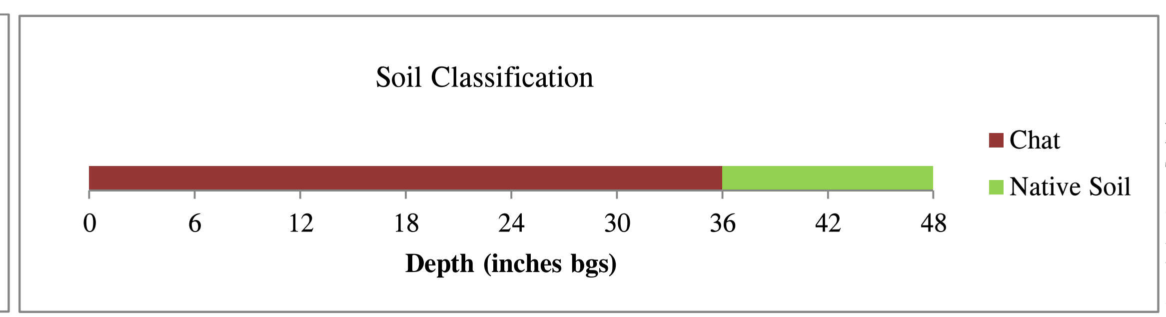




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**701**	**6,876**	**48**
6-12	**424**	**13,891**	**28**
12-18	**364**	**5,315**	**20**
18-24	**333**	**3,703**	< 13.9
24-30	**7,855**	**7,010**	**31**
30-36	**7,739**	**6,993**	**29**
36-42	**192**	**393**	< 12.9
42-48	**42**	**184**	< 12.8

Test Pit 26B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**313**	**6,238**	**20**
6-12	**327**	**12,599**	**44**
12-18	**238**	**10,995**	**20**
18-24	**448**	**8,851**	**19**
24-30	**708**	**1,868**	< 12.7
30-36	**185**	**1,217**	**28**
36-42	**110**	**744**	< 13.1
42-48	< 10.4	**47**	< 13.2

Test Pit 26B-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**85**	**480**	< 13.1

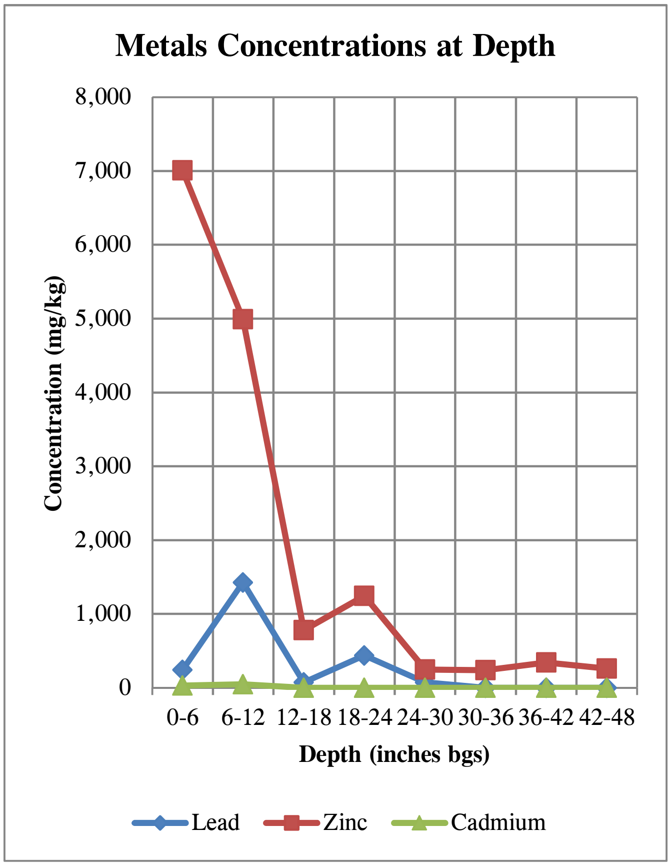
Metals concentration graphs and soil classification profiles are not shown for test pits at which lead concentrations were below the Regional Screening Level.

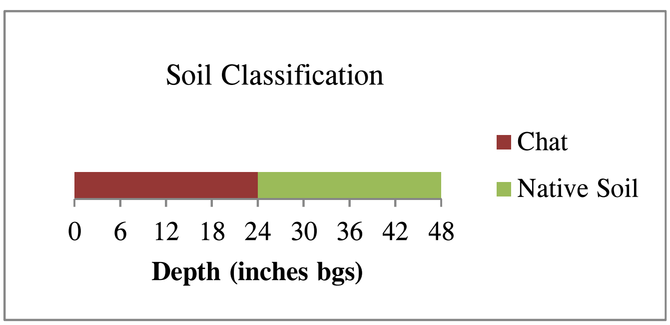
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.27
Metals Concentrations at Depth - Location 27
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

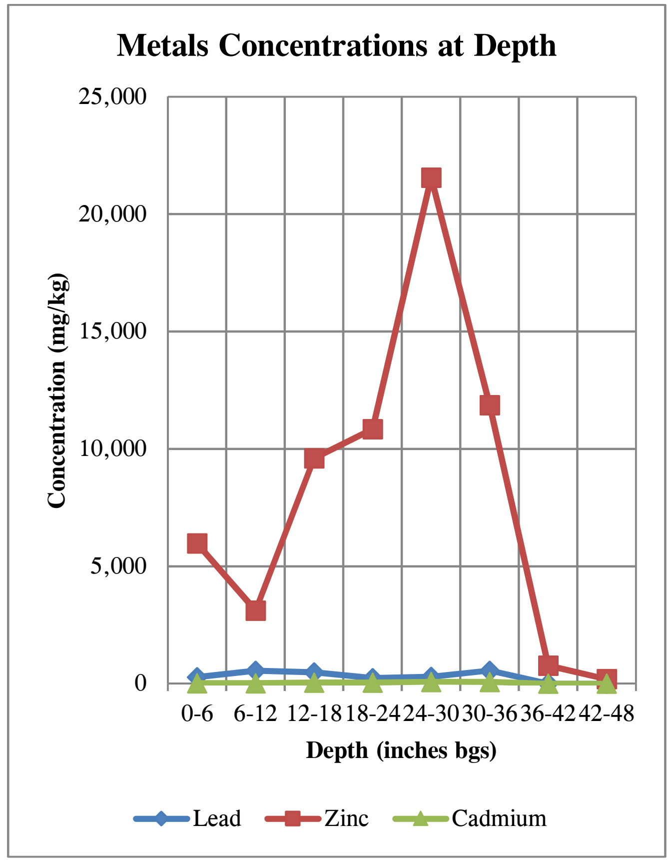
Test Pit 27A

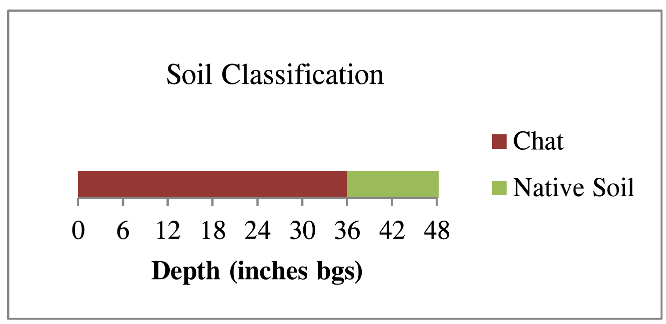




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**244**	**7,010**	**29**
6-12	**1,428**	**4,993**	**46**
12-18	**74**	**780**	< 13.4
18-24	**439**	**1,244**	< 12.9
24-30	**75**	**248**	< 13.0
30-36	< 9.2	**237**	< 12.9
36-42	< 9.3	**340**	< 12.7
42-48	< 9.0	**258**	< 12.9

Test Pit 27B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**276**	**5,983**	**21**
6-12	**549**	**3,120**	**20**
12-18	**485**	**9,610**	**41**
18-24	**239**	**10,847**	**42**
24-30	**291**	**21,567**	**79**
30-36	**555**	**11,867**	**69**
36-42	< 9.5	**769**	< 12.3
42-48	< 11.2	**192**	< 13.3

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

(shaded box) - Above Residential RSL

bgs - below ground surface

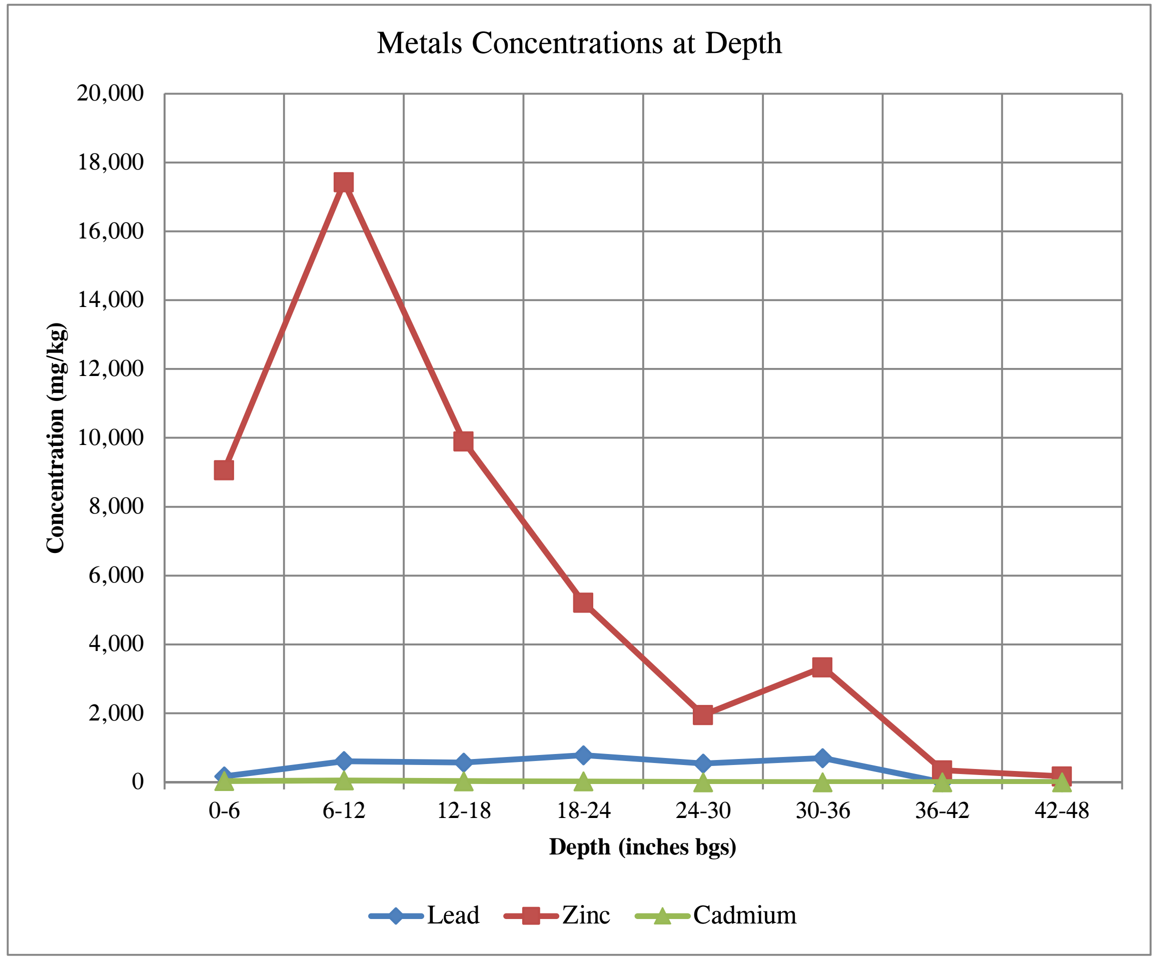
mg/kg - milligrams per kilogram

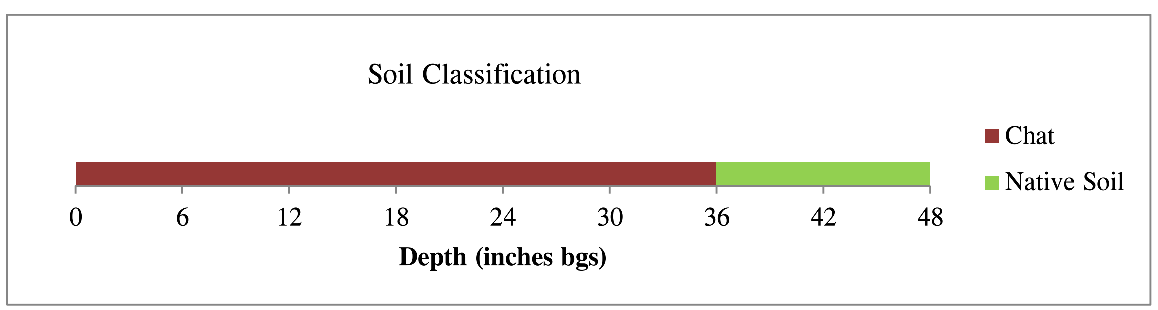
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.28
Metals Concentrations at Depth - Location 28
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

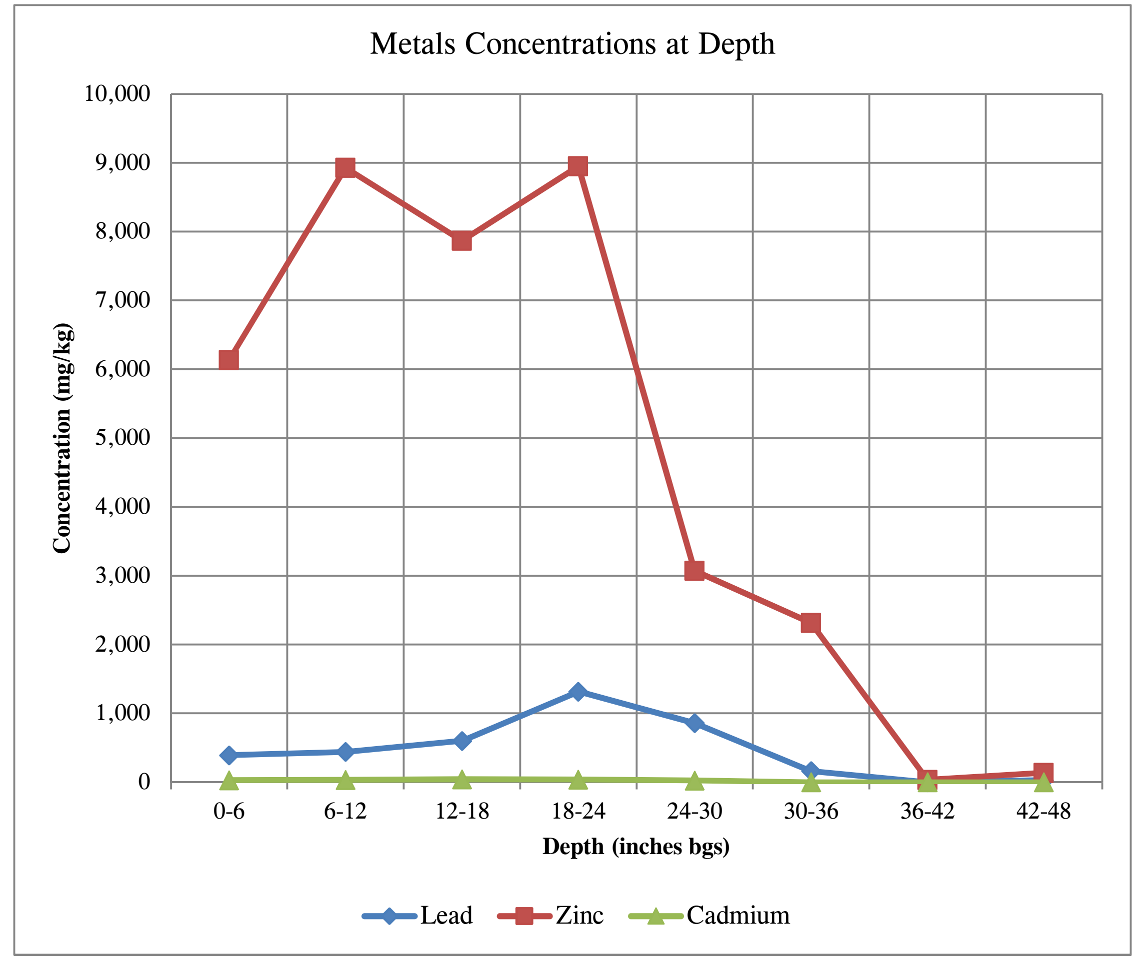
Test Pit 28A

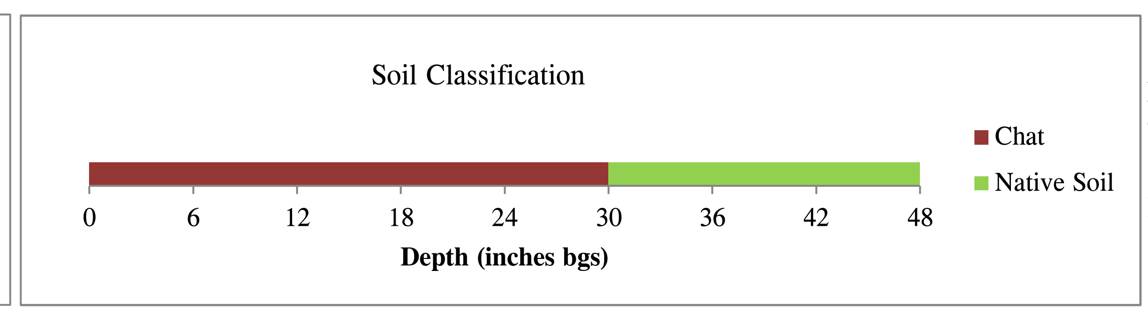




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**170**	**9,061**	**33**
6-12	**611**	**17,433**	**52**
12-18	**570**	**9,903**	**29**
18-24	**784**	**5,214**	**24**
24-30	**541**	**1,957**	< 14.5
30-36	**699**	**3,336**	< 14.0
36-42	< 11.6	**343**	< 13.4
42-48	< 9.1	**170**	< 13.1

Test Pit 28B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**391**	**6,136**	**31**
6-12	**441**	**8,932**	**33**
12-18	**600**	**7,870**	**44**
18-24	**1,319**	**8,951**	**37**
24-30	**859**	**3,073**	**24**
30-36	**162**	**2,315**	< 14.1
36-42	< 10.5	**35**	< 14.0
42-48	**31**	**136**	< 13.3

Test Pit 28A-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**97**	**1,357**	< 13.5

Test Pit 28B-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**48**	**703**	< 12.4

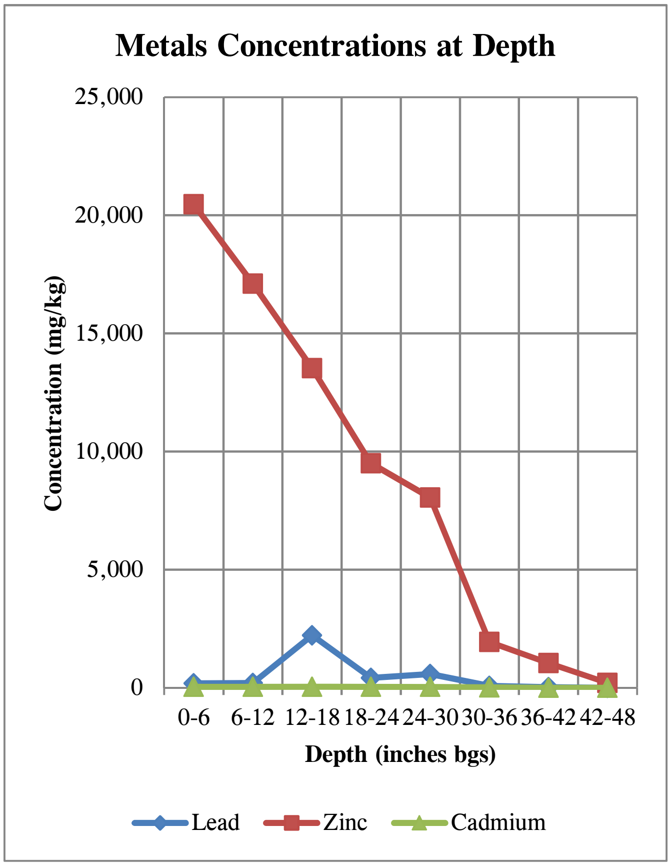
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

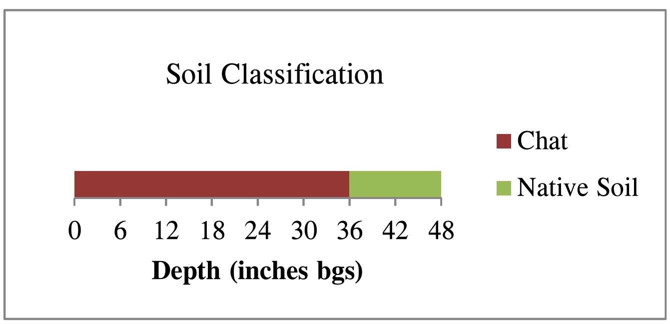
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.29
Metals Concentrations at Depth - Location 29
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

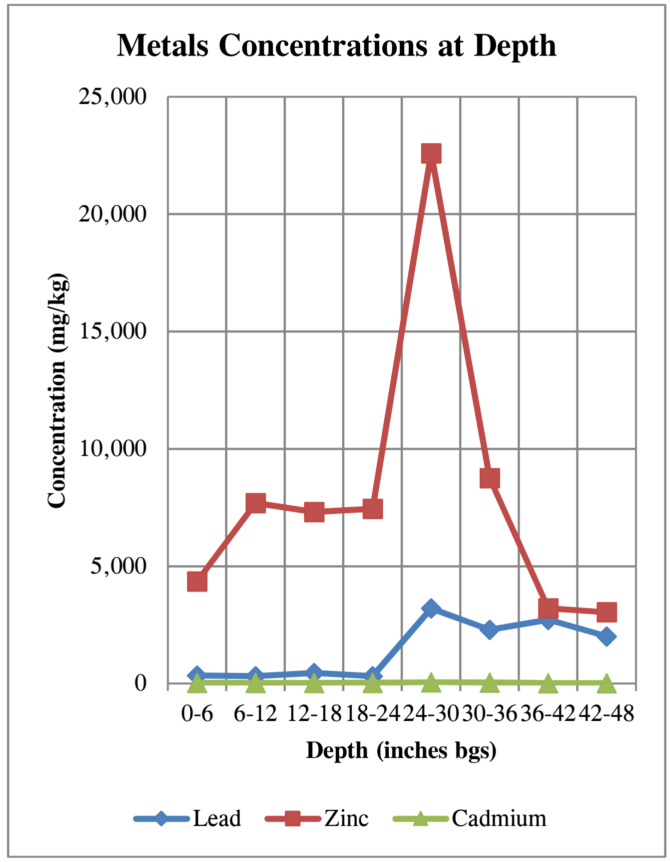
Test Pit 29A

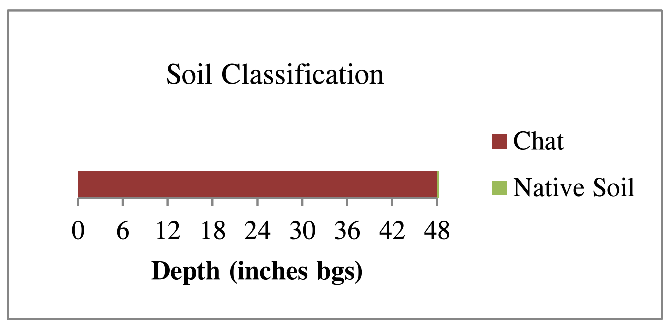




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**190**	**20,467**	**35**
6-12	**197**	**17,100**	**37**
12-18	**2,218**	**13,519**	**37**
18-24	**422**	**9,494**	**40**
24-30	**584**	**8,048**	**34**
30-36	**86**	**1,940**	**18**
36-42	**27**	**1,046**	< 13.0
42-48	< 8.4	**199**	< 13.4

Test Pit 29B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**343**	**4,361**	**27**
6-12	**321**	**7,693**	**27**
12-18	**457**	**7,309**	**37**
18-24	**324**	**7,448**	**32**
24-30	**3,205**	**22,603**	**67**
30-36	**2,289**	**8,755**	**48**
36-42	**2,720**	**3,214**	**23**
42-48	**2,013**	**3,040**	**24**

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg   Lead - 400 mg/kg   Zinc - 2,300 mg/kg

- Above Residential RSL

bgs - below ground surface

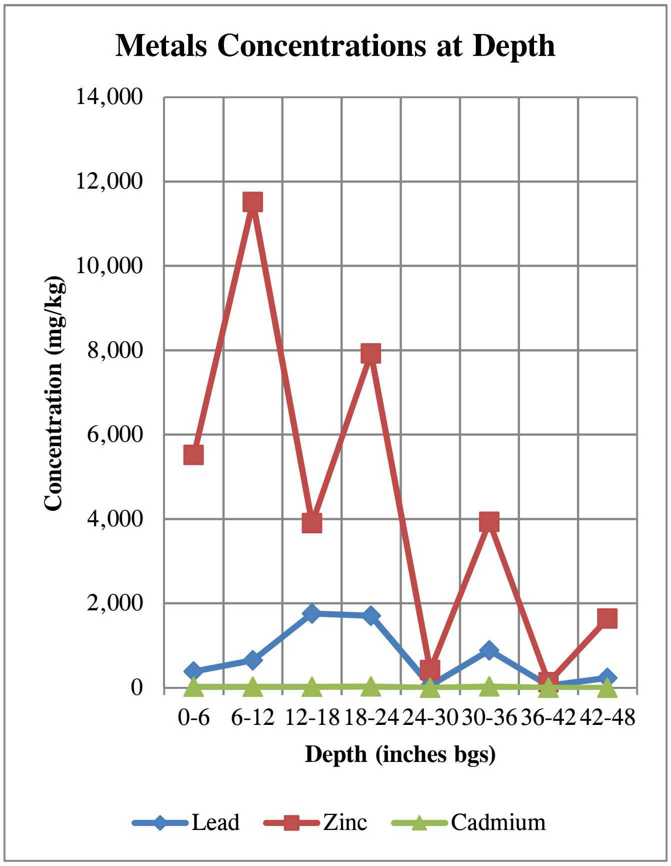
mg/kg - milligrams per kilogram

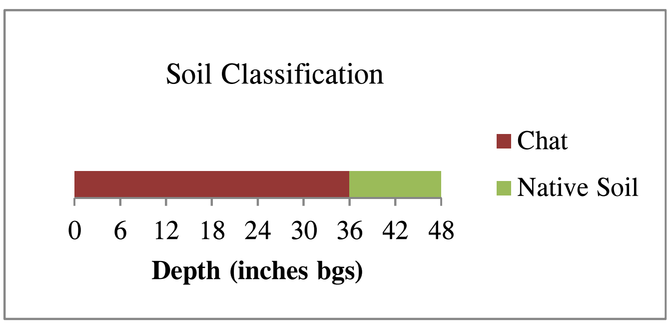
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.30
Metals Concentrations at Depth - Location 30
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

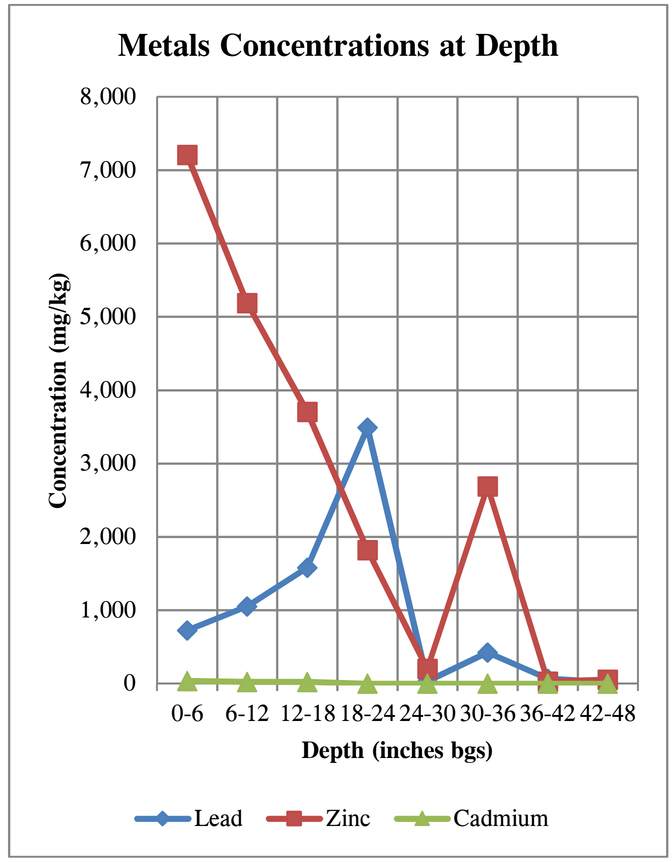
Test Pit 30A

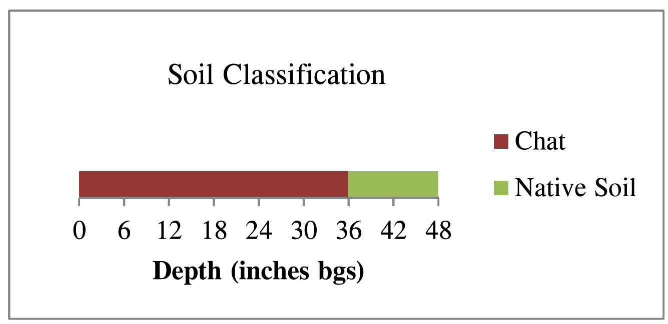




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**386**	**5,514**	**23**
6-12	**653**	**11,509**	**23**
12-18	**1,759**	**3,903**	**20**
18-24	**1,706**	**7,926**	**29**
24-30	**54**	**417**	< 13.4
30-36	**887**	**3,928**	**30**
36-42	**51**	**126**	< 14.8
42-48	**237**	**1,636**	< 13.9

Test Pit 30B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**727**	**7,211**	**37**
6-12	**1,054**	**5,191**	**23**
12-18	**1,582**	**3,707**	**23**
18-24	**3,490**	**1,821**	< 14.3
24-30	**32**	**204**	< 12.9
30-36	**425**	**2,688**	< 13.4
36-42	**68**	**30**	< 13.5
42-48	**18**	**55**	< 13.6

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

[grey box] - Above Residential RSL

bgs - below ground surface

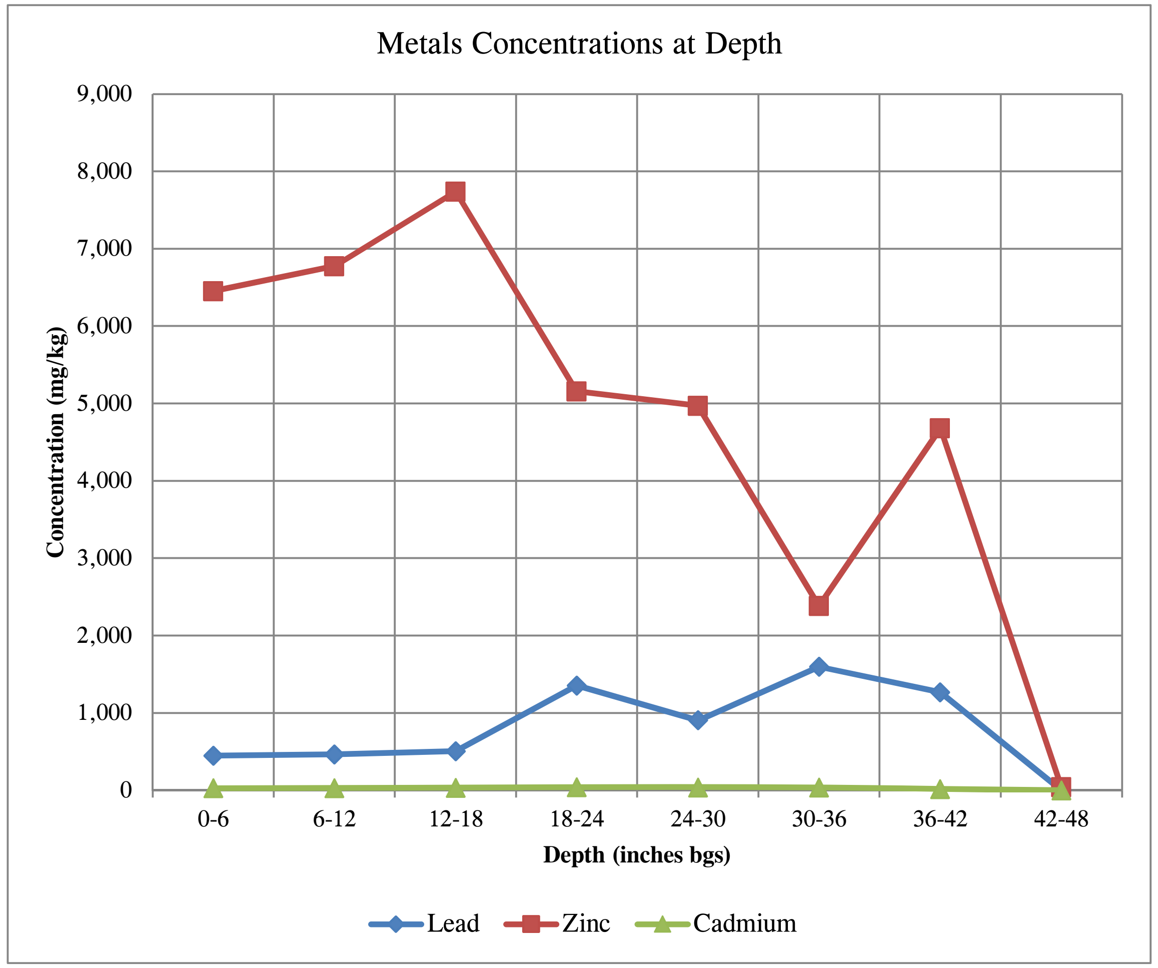
mg/kg - milligrams per kilogram

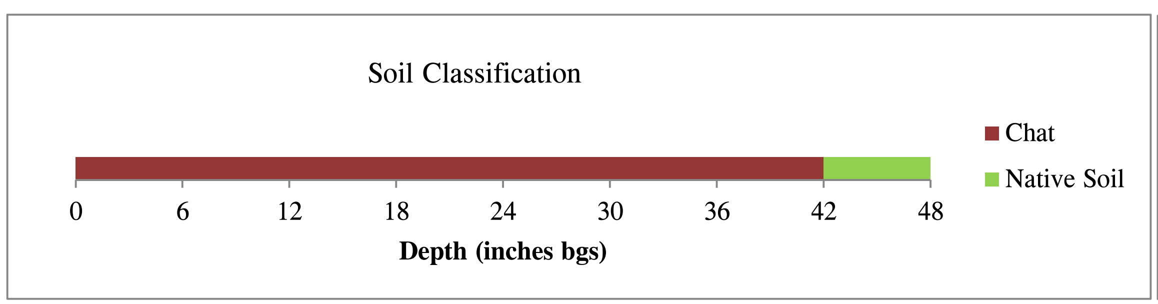
Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.31
Metals Concentrations at Depth - Location 31
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

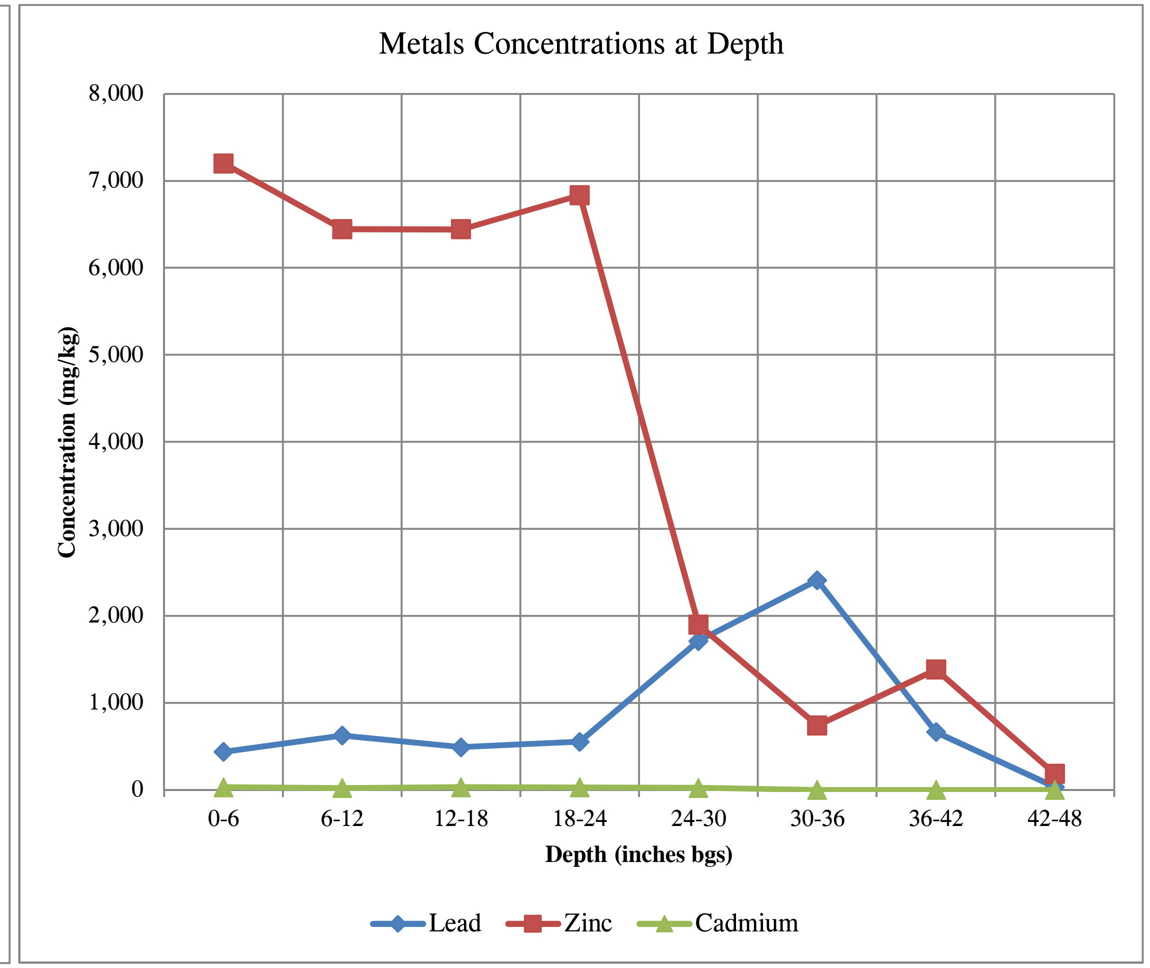
Test Pit 31A

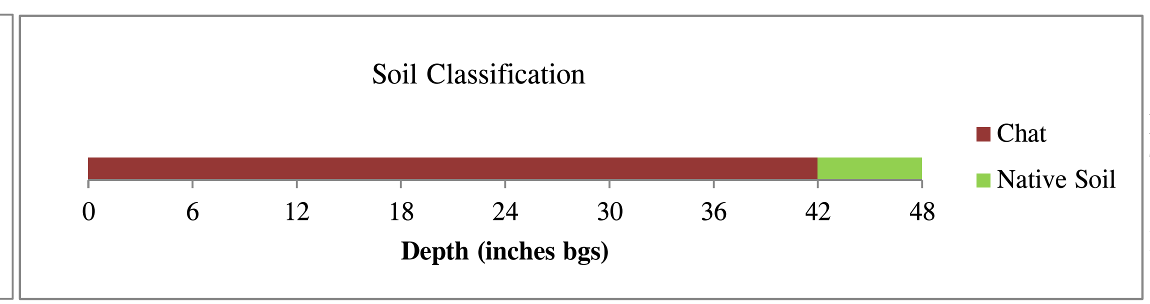




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**446**	**6,454**	**27**
6-12	**463**	**6,775**	**30**
12-18	**507**	**7,740**	**33**
18-24	**1,355**	**5,157**	**43**
24-30	**905**	**4,972**	**39**
30-36	**1,598**	**2,386**	**38**
36-42	**1,266**	**4,682**	**17**
42-48	< 10.9	**41**	< 13.8

Test Pit 31B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**437**	**7,201**	**31**
6-12	**625**	**6,446**	**22**
12-18	**492**	**6,445**	**32**
18-24	**555**	**6,835**	**29**
24-30	**1,713**	**1,898**	**23**
30-36	**2,411**	**741**	< 14.9
36-42	**666**	**1,383**	< 13.8
42-48	**33**	**185**	< 12.7

Test Pit 31A-S

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**81**	**342**	< 12.8

Test Pit 31A-N

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**44**	**376**	< 13.1

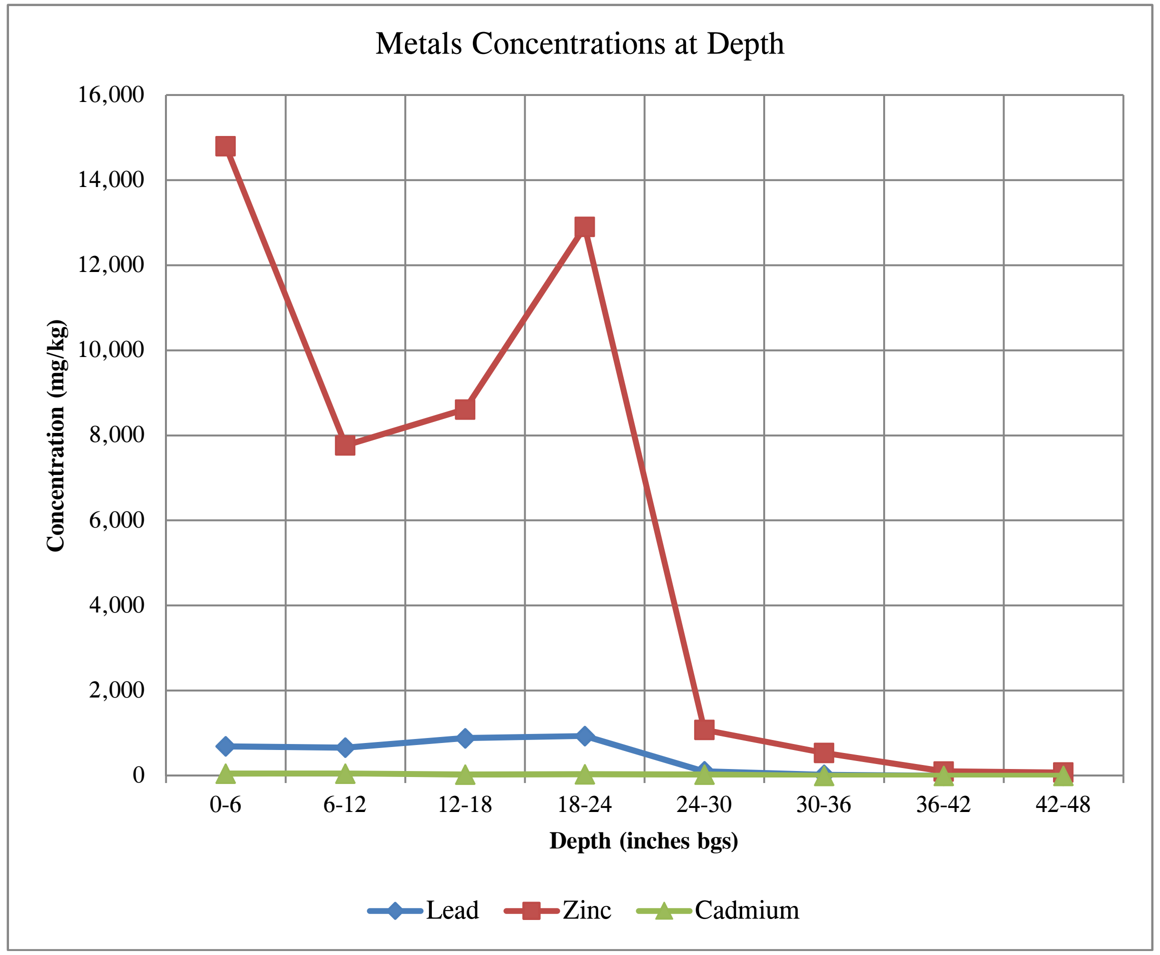
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

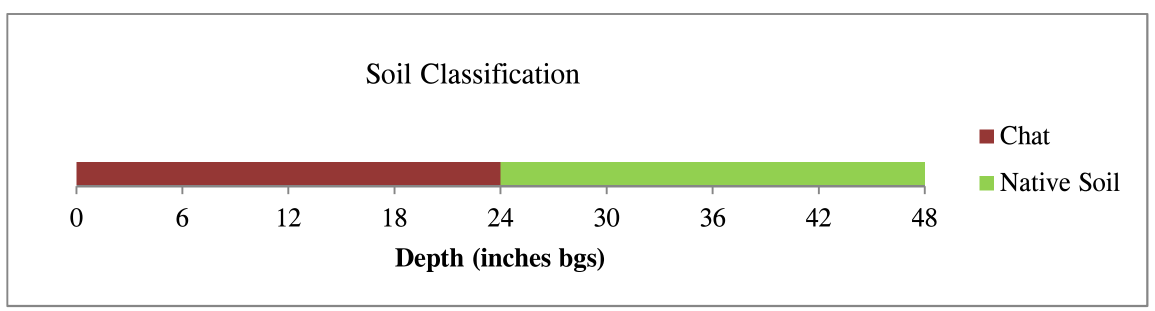
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

- Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.32
Metals Concentrations at Depth - Location 32
Field Screening Data
Cherokee County Site - OU8 Railroads
Cherokee County, Kansas

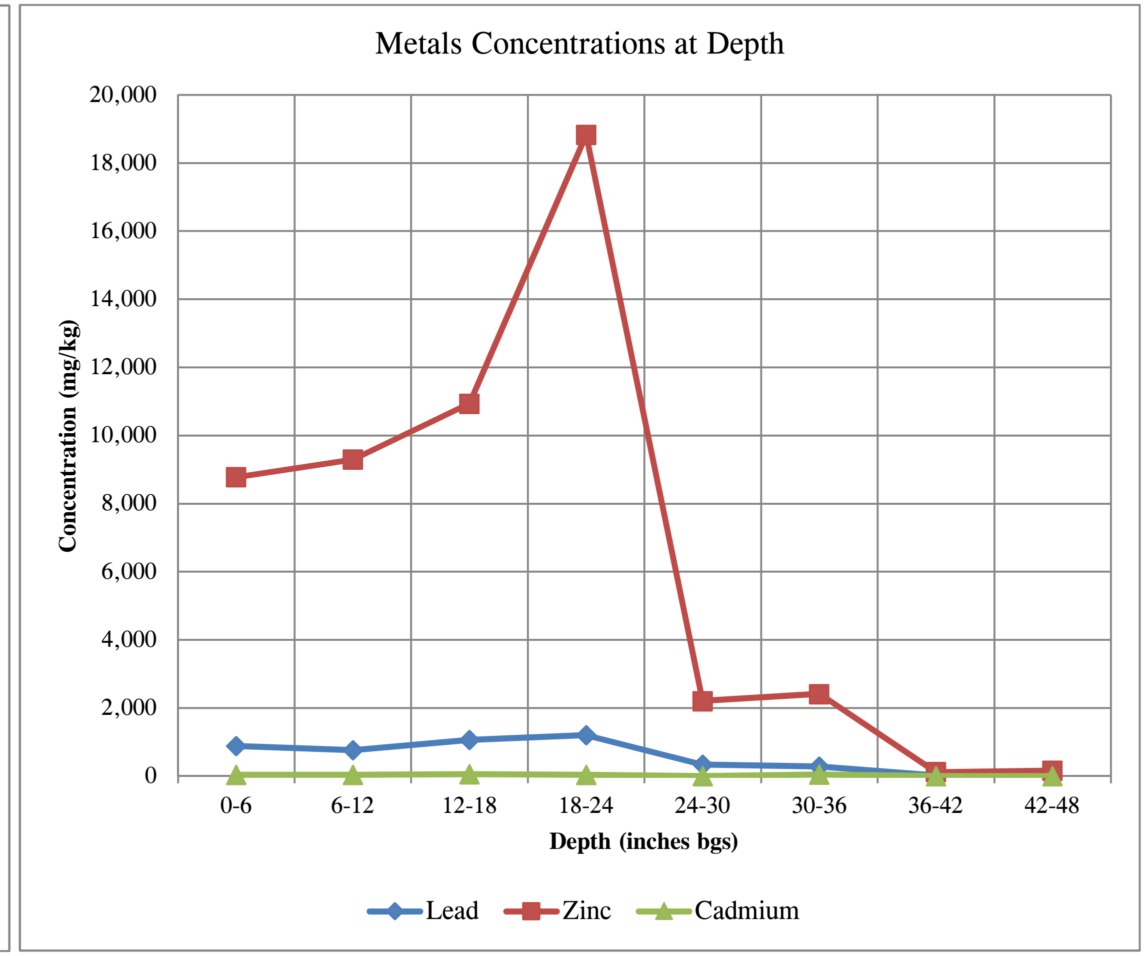
Test Pit 32A

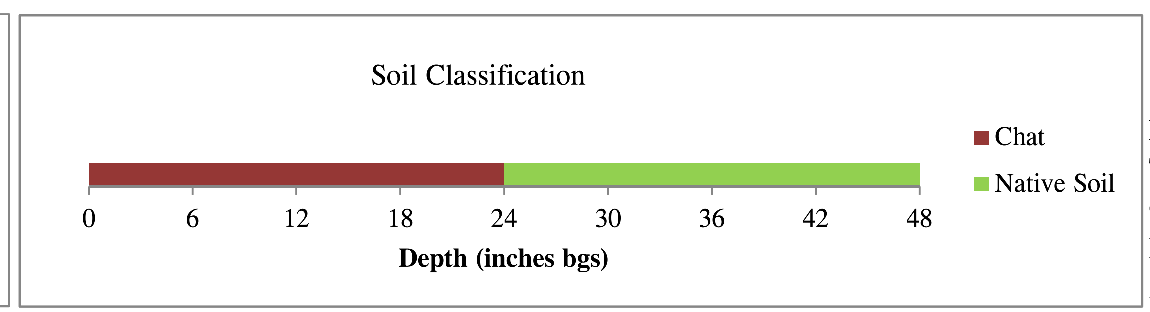




Depth	Metal Concentrations (mg/kg)		
(inches bgs)	Lead	Zinc	Cadmium
0-6	**691**	**14,800**	**46**
6-12	**658**	**7,767**	**51**
12-18	**880**	**8,611**	**29**
18-24	**932**	**12,902**	**35**
24-30	**99**	**1,079**	**26**
30-36	**16**	**537**	<10.8
36-42	<10.8	**98**	<13.1
42-48	<11.3	**76**	<13.1

Test Pit 32B





Depth	Metal Concentrations (mg/kg)		
(inches bgs)	Lead	Zinc	Cadmium
0-6	**882**	**8,779**	**37**
6-12	**760**	**9,297**	**35**
12-18	**1,060**	**10,933**	**55**
18-24	**1,200**	**18,833**	**35**
24-30	**332**	**2,202**	<13.5
30-36	**280**	**2,408**	**45**
36-42	**13**	**117**	<13.6
42-48	<12.1	**157**	<14.1

Test Pit 32B-E

Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**75**	**1,452**	<12.0

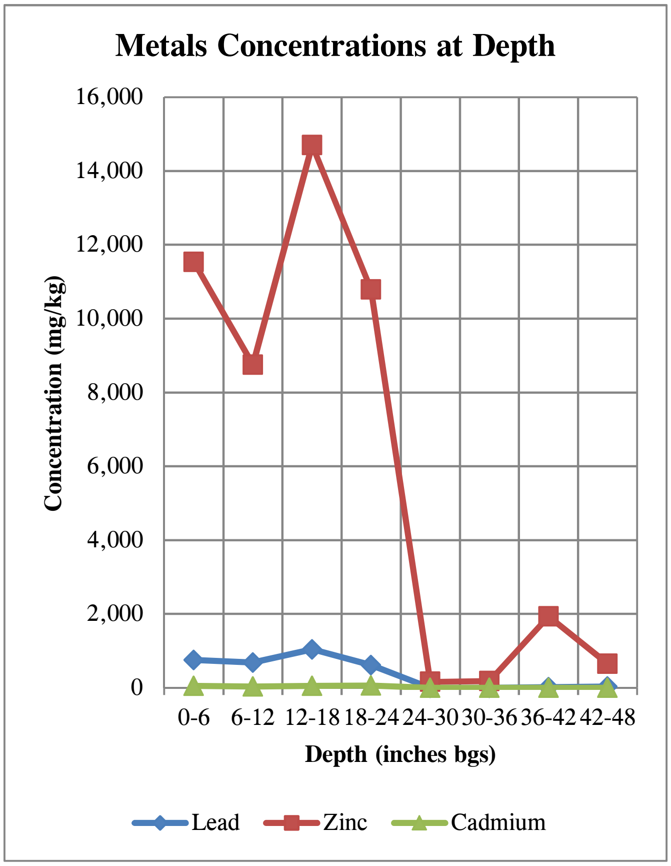
Metals concentration graphs and soil classification profiles are not shown for lateral test pits at which lead concentrations were below the Regional Screening Levels for lead.

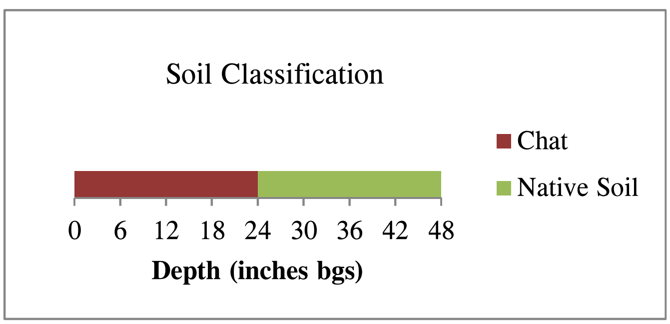
Residential Soil Regional Screening Levels
Total Hazard Quotient = 0.1 (June 2015)
Cadmium - 7.1 mg/kg
Lead - 400 mg/kg
Zinc - 2,300 mg/kg

[shaded box] - Above Regional Screening Level
bgs - below ground surface
mg/kg - milligrams per kilogram
Bold - Detection
Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.

Figure 5.33
Metals Concentrations at Depth - Location 33
Field Screening Data
Cherokee County Site - OU8 Railroads, Cherokee County, Kansas

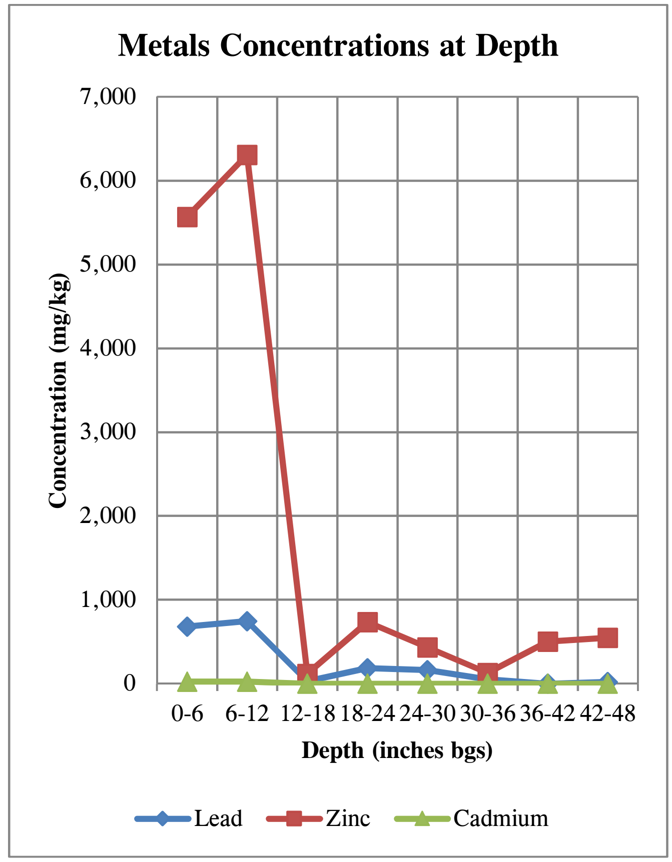
Test Pit 33A

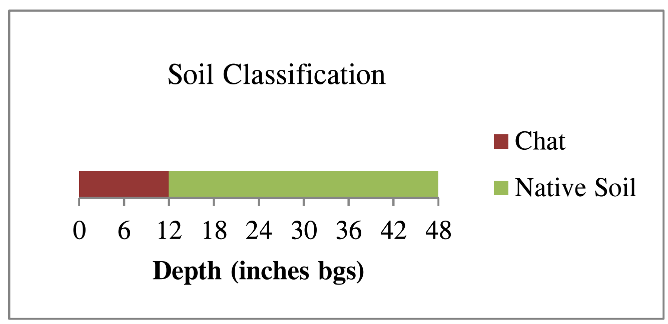




Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**750**	**11,533**	**49**
6-12	**686**	**8,748**	**37**
12-18	**1,040**	**14,700**	**49**
18-24	**612**	**10,790**	**58**
24-30	< 13.0	**159**	< 14.5
30-36	< 10.3	**182**	< 13.2
36-42	**12**	**1,935**	< 13.2
42-48	**29**	**651**	< 13.2

Test Pit 33B





Depth (inches bgs)	Metal Concentrations (mg/kg)		
	Lead	Zinc	Cadmium
0-6	**682**	**5,566**	**23**
6-12	**747**	**6,307**	**23**
12-18	**28**	**117**	< 14.4
18-24	**185**	**734**	< 14.1
24-30	**164**	**433**	< 13.1
30-36	**52**	**127**	< 13.8
36-42	< 10.6	**502**	< 12.7
42-48	**19**	**547**	< 13.0

Residential Soil Regional Screening Levels HQ=0.1: Cadmium - 7.1 mg/kg Lead - 400 mg/kg Zinc - 2,300 mg/kg

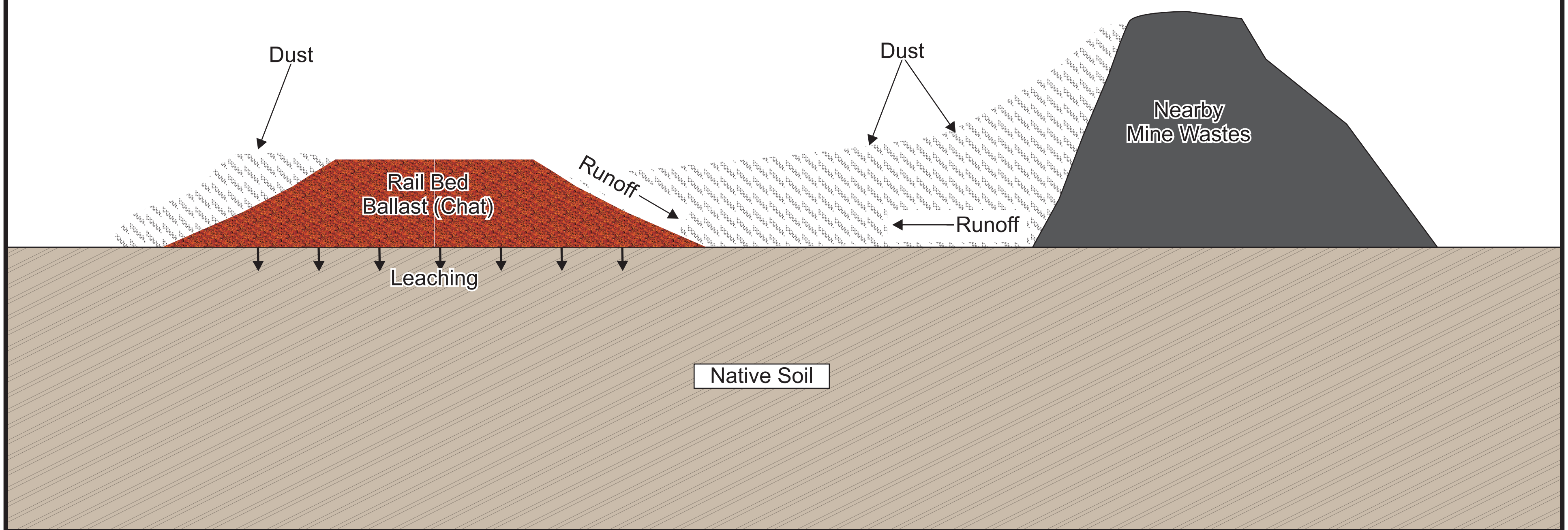
- Above Residential RSL

bgs - below ground surface

mg/kg - milligrams per kilogram

Bold - Detection

Non Bold - represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct representation.



Not to Scale

*\\Gst-srv-01\hglgis\Cherokee_County_MSIW\RI\
(6-01)Site_Conceptual_Model.cdr
8/20/2015 JG
Source: HGL*

HGL HydroGeoLogic, Inc

Figure 6.1
Conceptual Site Model

APPENDIX A

SOIL SURVEY REPORT

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United States Department of Agriculture

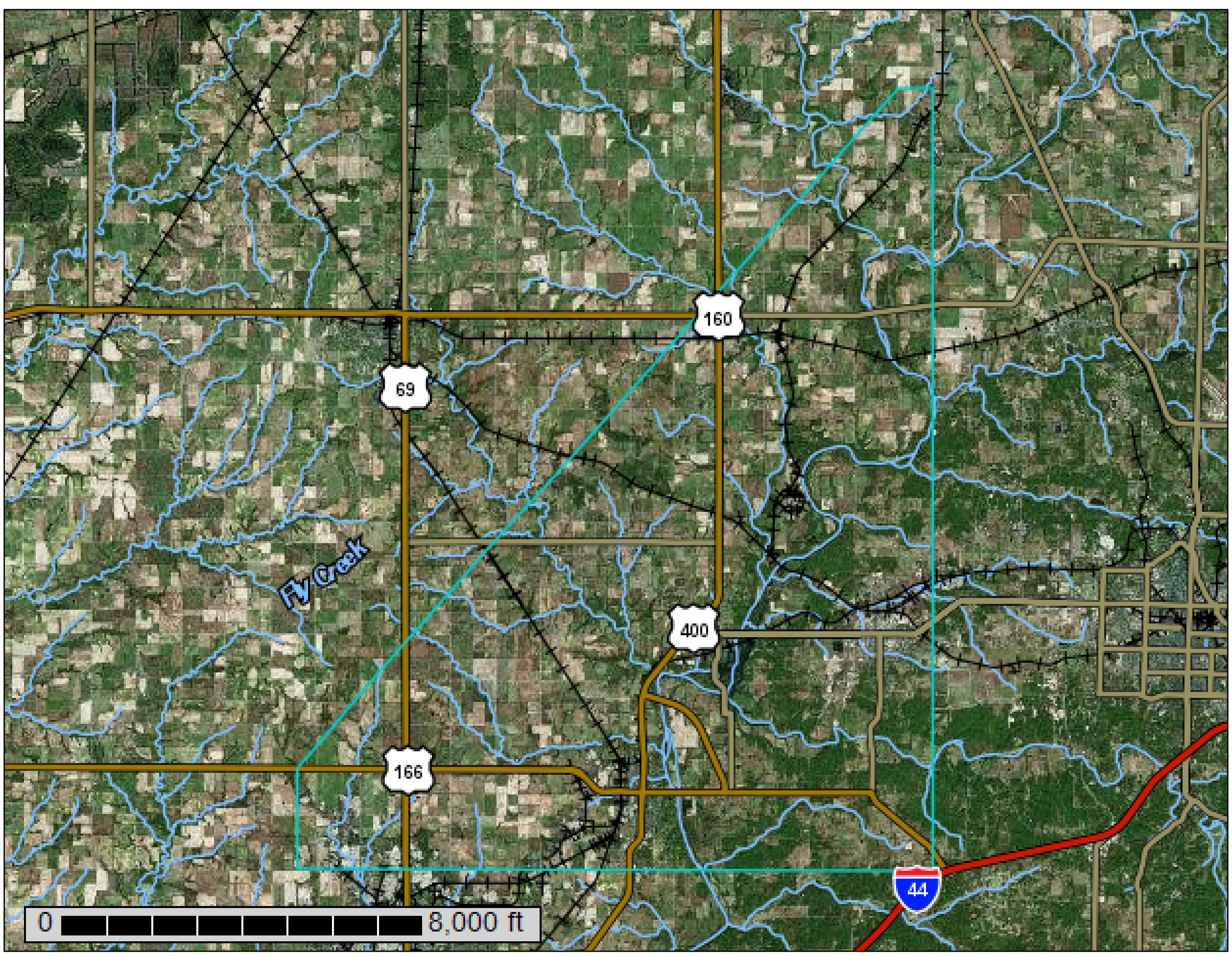
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Cherokee County, Kansas, Jasper County, Missouri, Newton County, Missouri, and Ottawa County, Oklahoma

Cherokee County OU8



August 17, 2015

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

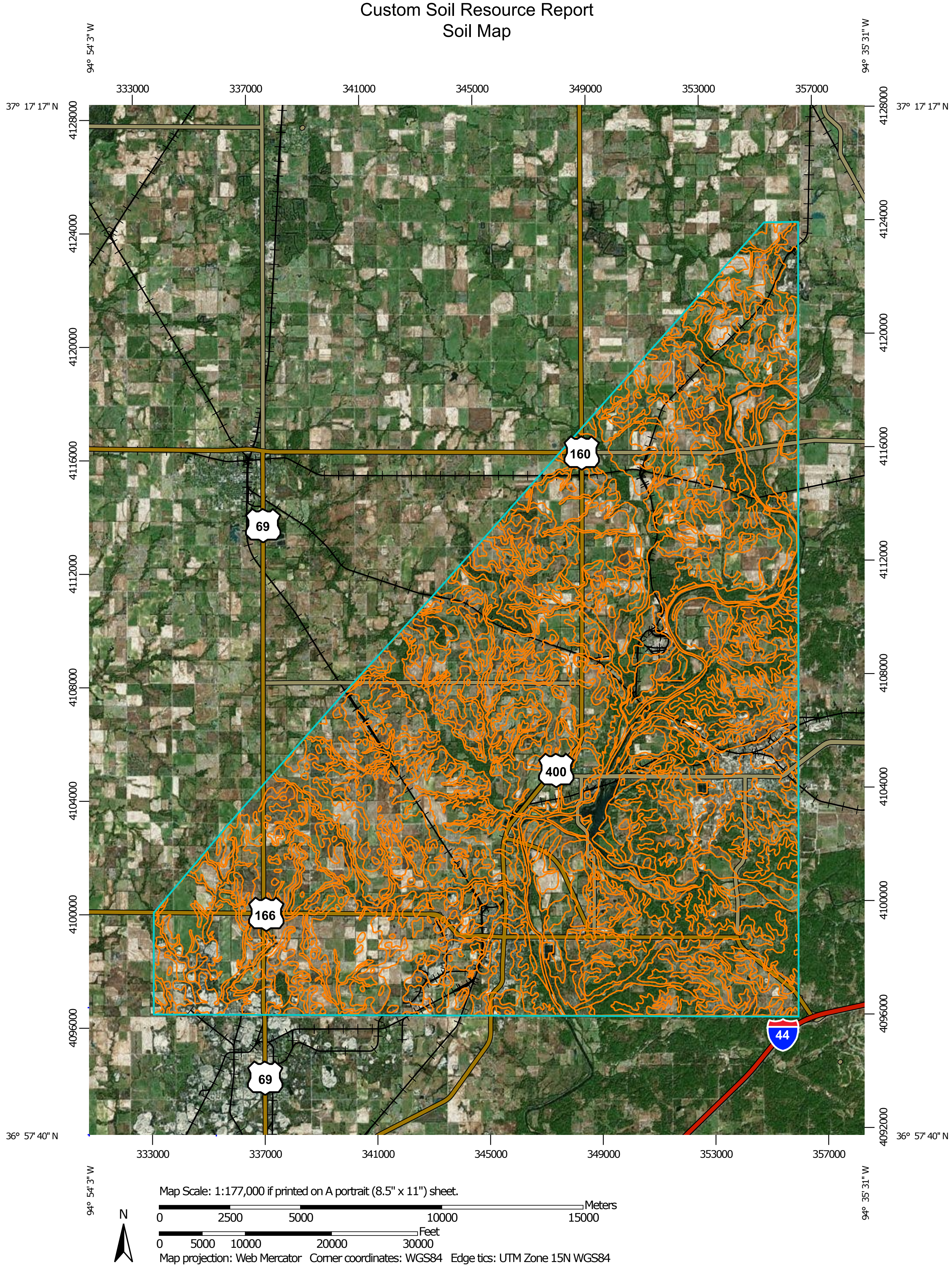
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


94° 54' 3" W
94° 35' 31" W
333000
337000
341000
345000
349000
353000
357000
37° 17' 17" N
4128000
4124000
4120000
4116000
4112000
4108000
4104000
4100000
4096000
4092000
160
69
400
166
44
36° 57' 40" N
Map Scale: 1:177,000 if printed on A portrait (8.5" x 11") sheet.
Meters
0 2500 5000 10000 15000
Feet
0 5000 10000 20000 30000
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Cherokee County, Kansas
Survey Area Data: Version 14, Aug 28, 2014

Soil Survey Area: Jasper County, Missouri
Survey Area Data: Version 15, Sep 9, 2014

Soil Survey Area: Newton County, Missouri
Survey Area Data: Version 14, Sep 9, 2014

Soil Survey Area: Ottawa County, Oklahoma
Survey Area Data: Version 9, Sep 16, 2014

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Cherokee County, Kansas (KS021)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
8100	Hepler silt loam, frequently flooded	2,520.5	2.7%
8101	Hepler silt loam, occasionally flooded	7,438.2	8.0%
8150	Lanton silt loam, occasionally flooded	1,147.6	1.2%
8302	Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded	2,528.5	2.7%
8460	Cherokee silt loam, 0 to 1 percent slopes	1,262.4	1.3%
8621	Bates loam, 1 to 3 percent slopes	6,010.4	6.4%
8623	Bates loam, 3 to 7 percent slopes	1,002.0	1.1%
8627	Bates-Collinsville complex, 3 to 15 percent slopes	1,778.5	1.9%
8679	Dennis silt loam, 1 to 3 percent slopes	23,459.6	25.1%
8863	Parsons silt loam, 0 to 1 percent slopes	1,907.6	2.0%
8927	Taloka silt loam, 0 to 1 percent slopes	15,557.9	16.6%
9050	Secesh silt loam, channeled	525.8	0.6%
9150	Secesh silt loam, rarely flooded	924.9	1.0%
9211	Bolivar-Hector complex, 5 to 15 percent slopes	3,182.7	3.4%
9250	Clarksville very cherty silt loam, 10 to 30 percent slopes	7,556.4	8.1%
9260	Gerald silt loam, 0 to 2 percent slopes	862.0	0.9%
9270	Nixa very gravelly silt loam, 3 to 8 percent slopes	6,568.5	7.0%
9280	Tonti silt loam, 2 to 5 percent slopes	2,751.1	2.9%
9290	Waben cherty silt loam, 2 to 5 percent slopes	1,680.2	1.8%
9975	Dumps, mine	3,193.3	3.4%
9986	Miscellaneous water	256.2	0.3%
9999	Water	1,313.9	1.4%
Subtotals for Soil Survey Area		**93,428.1**	**99.9%**
Totals for Area of Interest		**93,534.1**	**100.0%**

Ottawa County, Oklahoma (OK115)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Vd	Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded	0.3	0.0%
W	Water	0.3	0.0%
Subtotals for Soil Survey Area		**40.6**	**0.0%**
Totals for Area of Interest		**93,534.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Cherokee County, Kansas

8100—Hepler silt loam, frequently flooded

Map Unit Setting

National map unit symbol: 1jwsf
Elevation: 740 to 980 feet
Mean annual precipitation: 42 to 48 inches
Mean annual air temperature: 55 to 59 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Hepler and similar soils: 90 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hepler

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Silty alluvium

Typical profile

Ap - 0 to 8 inches: silt loam
E - 8 to 18 inches: silt loam
Btg - 18 to 48 inches: silt loam
2Btg - 48 to 80 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: Loamy Lowland (Draft) (PE 35-42) (R112XY013KS)
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)

Minor Components

Osage, occasionally flooded

Percent of map unit: 5 percent

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)

8101—Hepler silt loam, occasionally flooded

Map Unit Setting

National map unit symbol: 1jwsg
Elevation: 1,400 to 1,500 feet
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Hepler and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hepler

Setting

Landform: Flood-plain steps
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile

A - 0 to 7 inches: silt loam
E - 7 to 23 inches: silt loam
Bt - 23 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Very high (about 12.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Ecological site: Loamy Lowland (Draft) (PE 35-42) (R112XY013KS)

Minor Components

Osage, hydric

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clay Lowland (PE 35-42) (R112XY004KS)

8150—Lanton silt loam, occasionally flooded

Map Unit Setting

National map unit symbol: 1jwsh
Elevation: 350 to 700 feet
Mean annual precipitation: 31 to 47 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Lanton and similar soils: 95 percent
Minor components: 0 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lanton

Setting

Landform: Flood-plain steps
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty and clayey alluvium

Typical profile

A1 - 0 to 7 inches: silt loam
A2 - 7 to 21 inches: silt loam
Bw - 21 to 39 inches: silty clay loam
BC - 39 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 10.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Ecological site: Loamy Lowland (Draft) (PE 35-42) (R112XY013KS)

Minor Components

Osage, hydric

Percent of map unit: 0 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clay Lowland (PE 35-42) (R112XY004KS)

8302—Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2tgsl
Elevation: 460 to 1,560 feet
Mean annual precipitation: 37 to 45 inches
Mean annual air temperature: 55 to 61 degrees F
Frost-free period: 190 to 231 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Verdigris and similar soils: 82 percent
Minor components: 8 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Verdigris

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile

Ap - 0 to 7 inches: silt loam
A - 7 to 28 inches: silt loam
AC - 28 to 46 inches: silt loam
C - 46 to 79 inches: silt loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water storage in profile: Very high (about 12.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B
Ecological site: Loamy Lowland (Draft) (PE 35-42) (R112XY013KS)

Minor Components

Osage, hydric

Percent of map unit: 8 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clay Lowland (PE 35-42) (R112XY004KS)

8460—Cherokee silt loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 1jwsl
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Cherokee and similar soils: 100 percent
Minor components: 0 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cherokee

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over ancient clayey alluvium

Typical profile

A - 0 to 7 inches: silt loam
E - 7 to 14 inches: silt loam

Bt - 14 to 36 inches: silty clay
Btg - 36 to 47 inches: silty clay
BC - 47 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: C/D
Ecological site: Clay Upland (PE 35-42) (R112XY007KS)

Minor Components

Aquolls

Percent of map unit: 0 percent
Landform: Depressions, drainageways
Down-slope shape: Concave
Across-slope shape: Concave

8621—Bates loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2r2nb
Elevation: 710 to 1,360 feet
Mean annual precipitation: 39 to 45 inches
Mean annual air temperature: 55 to 61 degrees F
Frost-free period: 188 to 223 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Bates and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bates

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Residuum weathered from sandstone and shale

Typical profile

A - 0 to 9 inches: loam
BA - 9 to 16 inches: loam
Bt - 16 to 23 inches: clay loam
BC - 23 to 33 inches: clay loam
Cr - 33 to 43 inches: bedrock

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: Sandstone/Shale Upland Prairie (R112XY016MO)

8623—Bates loam, 3 to 7 percent slopes

Map Unit Setting

National map unit symbol: 2tgsh
Elevation: 480 to 1,310 feet
Mean annual precipitation: 39 to 45 inches
Mean annual air temperature: 55 to 61 degrees F
Frost-free period: 188 to 223 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Bates and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bates

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from sandstone and shale

Typical profile

A - 0 to 11 inches: loam
BA - 11 to 16 inches: loam
Bt - 16 to 23 inches: clay loam
BC - 23 to 30 inches: clay loam
Cr - 30 to 40 inches: bedrock

Properties and qualities

Slope: 3 to 7 percent
Depth to restrictive feature: 24 to 38 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Sandstone/Shale Upland Prairie (R112XY016MO)

8627—Bates-Collinsville complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: 1jwsp
Elevation: 700 to 1,360 feet
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Not prime farmland

Map Unit Composition

Bates and similar soils: 45 percent
Collinsville and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bates

Setting

Landform: Interfluves
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and silty residuum weathered from sandstone and shale

Typical profile

A - 0 to 8 inches: loam

Bt - 8 to 12 inches: loam
BC - 12 to 27 inches: clay loam
Cr - 27 to 28 inches: weathered bedrock

Properties and qualities

Slope: 3 to 6 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Loamy Upland (Draft) (PE 35-42) (R112XY015KS)

Description of Collinsville

Setting

Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from sandstone

Typical profile

A - 0 to 14 inches: fine sandy loam
R - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 4 to 15 percent
Depth to restrictive feature: 4 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Shallow Sandstone (Draft) (PE 35-42) (R112XY030KS)

8679—Dennis silt loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tgsq
Elevation: 460 to 1,260 feet
Mean annual precipitation: 37 to 45 inches
Mean annual air temperature: 55 to 61 degrees F
Frost-free period: 150 to 255 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Dennis and similar soils: 82 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dennis

Setting

Landform: Interfluves
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Base slope, interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Silty and clayey residuum weathered from shale

Typical profile

A - 0 to 11 inches: silt loam
BA - 11 to 17 inches: silty clay loam
Bt1 - 17 to 22 inches: silty clay
Bt2 - 22 to 68 inches: silty clay
C - 68 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: Loamy Upland (Draft) (PE 35-42) (R112XY015KS)

8863—Parsons silt loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2thdx
Elevation: 510 to 1,340 feet
Mean annual precipitation: 35 to 45 inches
Mean annual air temperature: 55 to 61 degrees F
Frost-free period: 175 to 230 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Parsons and similar soils: 85 percent
Minor components: 0 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Parsons

Setting

Landform: Divides
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loess over clayey alluvium and/or clayey residuum weathered from clayey shale

Typical profile

Ap - 0 to 8 inches: silt loam
E - 8 to 14 inches: silt loam
2Btg1 - 14 to 24 inches: silty clay
2Btg2 - 24 to 39 inches: silty clay
2BC - 39 to 59 inches: silty clay loam
2C - 59 to 79 inches: silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: 9 to 17 inches to abrupt textural change
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Gypsum, maximum in profile: 6 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D

Ecological site: Claypan Summit Prairie (R112XY011MO)

Minor Components

Aquolls

Percent of map unit: 0 percent
Landform: Divides
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: Clay Upland (PE 35-42) (R112XY007KS)

8927—Taloka silt loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2thf3
Elevation: 500 to 1,200 feet
Mean annual precipitation: 37 to 45 inches
Mean annual air temperature: 54 to 63 degrees F
Frost-free period: 185 to 255 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Taloka and similar soils: 92 percent
Minor components: 0 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Taloka

Setting

Landform: Paleoterraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy and clayey alluvium and/or loamy and clayey colluvium over residuum weathered from sandstone and shale

Typical profile

Ap - 0 to 8 inches: silt loam
E - 8 to 20 inches: silt loam
2Btg1 - 20 to 24 inches: silty clay
2Btg2 - 24 to 39 inches: silty clay
2BC - 39 to 59 inches: silty clay loam
2C - 59 to 79 inches: silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: 9 to 24 inches to abrupt textural change
Natural drainage class: Somewhat poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Gypsum, maximum in profile: 6 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: D
Ecological site: Loamy prairie (Northeast) PE 62-80 (R112XY059OK)

Minor Components

Aquolls
Percent of map unit: 0 percent
Landform: Divides
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: Clay Upland (PE 35-42) (R112XY007KS)

9050—Secesh silt loam, channeled

Map Unit Setting
National map unit symbol: 1jwt1
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Not prime farmland

Map Unit Composition
Secesh and similar soils: 91 percent
Minor components: 0 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Secesh

Setting
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from limestone and sandstone

Typical profile
A - 0 to 10 inches: silt loam
BA - 10 to 25 inches: silty clay loam

Bt1 - 25 to 43 inches: very gravelly silty clay loam
2Bt2 - 43 to 60 inches: extremely gravelly clay loam

Properties and qualities

Slope: 1 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B
Ecological site: Loamy Lowland (Draft) (PE 35-42) (R112XY013KS)

Minor Components

Osage, hydric

Percent of map unit: 0 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clay Lowland (PE 35-42) (R112XY004KS)

9150—Secesh silt loam, rarely flooded

Map Unit Setting

National map unit symbol: 1jwt2
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Secesh and similar soils: 95 percent
Minor components: 0 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Secesh

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Alluvium derived from limestone and sandstone

Typical profile

A - 0 to 10 inches: silt loam
BA - 10 to 25 inches: silty clay loam
Bt1 - 25 to 43 inches: very gravelly silty clay loam
2Bt2 - 43 to 60 inches: extremely gravelly clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B
Ecological site: Loamy Lowland (Draft) (PE 35-42) (R112XY013KS)

Minor Components

Osage, hydric

Percent of map unit: 0 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clay Lowland (PE 35-42) (R112XY004KS)

9211—Bolivar-Hector complex, 5 to 15 percent slopes

Map Unit Setting

National map unit symbol: 1jwt3
Elevation: 500 to 2,400 feet
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Not prime farmland

Map Unit Composition

Bolivar and similar soils: 55 percent
Hector and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bolivar

Setting

Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from sandstone

Typical profile

A - 0 to 5 inches: fine sandy loam
E - 5 to 12 inches: fine sandy loam
Bt1 - 12 to 17 inches: clay loam
Bt2 - 17 to 36 inches: clay loam
Cr - 36 to 46 inches: weathered bedrock
R - 46 to 50 inches: unweathered bedrock

Properties and qualities

Slope: 4 to 15 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock; 37 to 79 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Available water storage in profile: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Savannah (Draft) (PE 35-42) (R112XY025KS)

Description of Hector

Setting

Landform: Interfluves
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from sandstone

Typical profile

A - 0 to 3 inches: fine sandy loam
Bw1 - 3 to 7 inches: fine sandy loam
Bw2 - 7 to 15 inches: fine sandy loam
R - 15 to 19 inches: unweathered bedrock

Properties and qualities

Slope: 4 to 15 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock

Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Shallow Savannah (Draft) (PE 35-42) (R112XY031KS)

9250—Clarksville very cherty silt loam, 10 to 30 percent slopes

Map Unit Setting

National map unit symbol: 1jwt4
Elevation: 700 to 1,300 feet
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Not prime farmland

Map Unit Composition

Clarksville and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Clarksville

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from cherty limestone

Typical profile

A - 0 to 4 inches: very gravelly silt loam
E - 4 to 23 inches: very gravelly silt loam
Bt1 - 23 to 32 inches: very gravelly silty clay loam
Bt2 - 32 to 60 inches: extremely gravelly silty clay loam

Properties and qualities

Slope: 10 to 30 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: Savannah (PE 37-45) (R116AY025KS)

9260—Gerald silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 1jwt5
Elevation: 800 to 1,300 feet
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Gerald and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gerald

Setting

Landform: Divides
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over residuum weathered from cherty limestone

Typical profile

A - 0 to 8 inches: silt loam
E - 8 to 13 inches: silt loam
Bt - 13 to 22 inches: silty clay
Btx - 22 to 42 inches: very gravelly silty clay loam
2Bt - 42 to 60 inches: extremely gravelly silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.01 to 0.06 in/hr)
Depth to water table: About 6 to 12 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D
Ecological site: Clay Upland (PE 35-42) (R112XY007KS)

9270—Nixa very gravelly silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2rk3t
Elevation: 920 to 1,530 feet
Mean annual precipitation: 39 to 49 inches
Mean annual air temperature: 54 to 59 degrees F
Frost-free period: 172 to 232 days
Farmland classification: Not prime farmland

Map Unit Composition

Nixa and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nixa

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over pedisediment over residuum weathered from limestone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: very gravelly silt loam
E - 3 to 10 inches: very gravelly silt loam
BE - 10 to 20 inches: very gravelly silt loam
2Btx - 20 to 43 inches: very gravelly silt loam
3Bt - 43 to 80 inches: very gravelly clay

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 11 to 30 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 9 to 28 inches
Frequency of flooding: None

Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: D
Ecological site: Quercus stellata-Quercus coccinea/Amelanchier arborea-Vaccinium pallidum/Helianthus hirsutus-Schizachyrium scoparium (F116BY004MO)
Other vegetative classification: Trees/Timber (Woody Vegetation)

9280—Tonti silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1jwt7
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Tonti and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonti

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from cherty limestone

Typical profile

A - 0 to 9 inches: silt loam
BA - 9 to 13 inches: gravelly silt loam
Bt - 13 to 19 inches: gravelly silty clay loam
Bx - 19 to 28 inches: very gravelly silty clay loam
B't - 28 to 60 inches: extremely gravelly silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.01 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: Savannah (PE 37-45) (R116AY025KS)

9290—Waben cherty silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1jwt8
Elevation: 1,000 to 1,400 feet
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Not prime farmland

Map Unit Composition

Waben and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Waben

Setting

Landform: Interfluves
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from cherty limestone and/or colluvium derived from cherty limestone

Typical profile

A - 0 to 10 inches: gravelly silt loam
Bt - 10 to 18 inches: gravelly silt loam
BC - 18 to 60 inches: extremely gravelly silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Ecological site: Loamy Upland (PE 37-45) (R116AY015KS)

9975—Dumps, mine

Map Unit Setting

National map unit symbol: 1jwt9
Mean annual precipitation: 19 to 67 inches
Mean annual air temperature: 54 to 61 degrees F
Frost-free period: 185 to 255 days
Farmland classification: Not prime farmland

Map Unit Composition

Dumps: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

9986—Miscellaneous water

Map Unit Setting

National map unit symbol: 1hk9s
Mean annual precipitation: 31 to 47 inches
Mean annual air temperature: 43 to 64 degrees F
Frost-free period: 175 to 215 days
Farmland classification: Not prime farmland

Map Unit Composition

Water, sewage lagoons: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

9999—Water

Map Unit Setting

National map unit symbol: 1hk9t
Elevation: 600 to 1,300 feet
Mean annual precipitation: 24 to 31 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 190 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

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APPENDIX B

PHOTOGRAPHIC DOCUMENTATION

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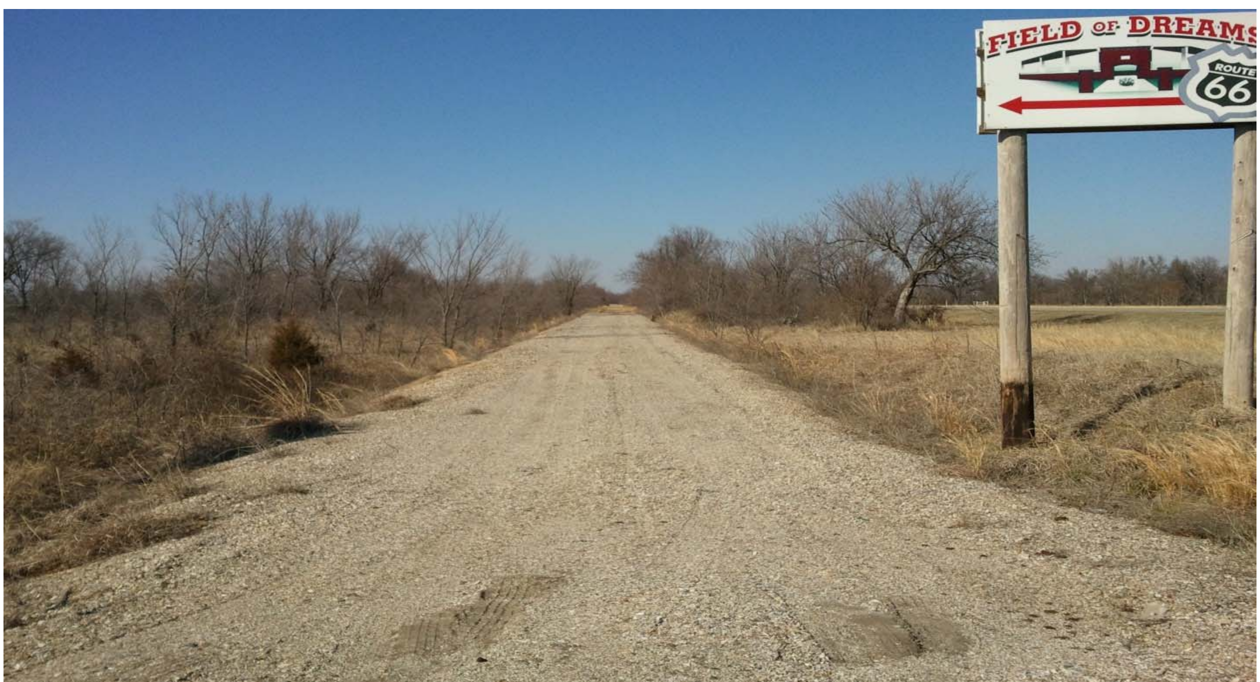
Photograph No.: 1	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: West	Time: NA	Project No.: EP9061

Description: Location 10 facing west from SE 40th Street.

Photograph No.: 2	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: Northeast	Time: NA	Project No.: EP9061

Description: Location 9 from just north of E 10th Road.

Photograph No.: 3	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: South	Time: NA	Project No.: EP9061
Description: Location 8 facing south from SW Star Rd.			



Photograph No.: 4	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: North	Time: NA	Project No.: EP9061
Description: Location 33 facing north from W North 10th Street.			

Photograph No.: 5	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: Southeast	Time: NA	Project No.: EP9061

Description: Location 32 facing south from W North 10th Street.

Photograph No.: 6	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: South	Time: NA	Project No.: EP9061

Description: Continuation of rail line from Location 32 where it crossed Willow Creek.

Photograph No.: 7	Photographer: A Fletcher	Date: 12-04-13	Contract: EPA AES
	Direction: Southeast	Time: NA	Project No.: EP9061
Description: Excavation at Location 32A south from W North 10th Street.			

Photograph No.: 8	Photographer: A Fletcher	Date: 03-08-13	Contract: EPA AES
	Direction: Down	Time: NA	Project No.: EP9061
Description: Gravel found on the surface of Location 25.			

Photograph No.: 9	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: West	Time: NA	Project No.: EP9061
Description: Location 24 facing west from Highway Alt 69			

Photograph No.: 10	Photographer: A Fletcher	Date: 12-3-13	Contract: EPA AES
	Direction: Northwest	Time: NA	Project No.: EP9061
Description: Location 24B excavation with chat visible in first lift.			

Photograph No.: 11	Photographer: A Fletcher	Date: 12-3-13	Contract: EPA AES
	Direction: Down	Time: NA	Project No.: EP9061

Description: Excavation at Location 24A with chat visible at depth.

Photograph No.: 12	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: West	Time: NA	Project No.: EP9061

Description: Description: Location 28 which is currently used as an access road.

Photograph No.: 13	Photographer: A Fletcher	Date: 5-8-13	Contract: EPA AES
	Direction: Down	Time: NA	Project No.: EP9061
Description: Location 9A where chat is visible in first 24 inches with native soil below.			

Photograph No.: 14	Photographer: A Fletcher	Date: 03-07-13	Contract: EPA AES
	Direction: West	Time: NA	Project No.: EP9061
Description: Location 14 between NE 107th Terrace and NE Lawton Road.			

Photograph No.: 15	Photographer: A Fletcher	Date: 03-08-13	Contract: EPA AES
	Direction: Northeast	Time: NA	Project No.: EP9061
Description: Location 15 from NE Lawton Road.			

Photograph No.: 16	Photographer: A Fletcher	Date: 05-10-13	Contract: EPA AES
	Direction: Down	Time: NA	Project No.: EP9061
Description: Location 14 with water encountered at 24 inches.			

<table>
<tr><td rowspan="2">Photograph No.: 17</td><td>Photographer: A Fletcher</td><td>Date: 03-07-13</td><td>Contract: EPA AES</td></tr>
<tr><td>Direction: West</td><td>Time: NA</td><td>Project No.: EP9061</td></tr>
<tr><td colspan="4">Description: Excavation at Location 1A north of SW Greenlawn Road.</td></tr>
</table>

APPENDIX C

XRF INSTRUMENT CALIBRATION CHECKS

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Manufacturer: Thermo Scientific
Number: XL3t-600
Number: 100718

Date/Time — ***Precision Measurement Check*** / ***Calibration Check***

5/8/2013 0850

Readings:	2591	2503	2596	2575	2574	2562	2586
Std Conc.:	2700						
Std Deviation:	32						
Mean Conc.:	2570						
RSD:	1.23						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	< LOD
Reading:	44	**Reading:**	< LOD

5/8/2013 1300

Readings:	2449	2713	2616	2086	2493	2592	2541
Std Conc.:	2700						
Std Deviation:	201						
Mean Conc.:	2499						
RSD:	8.05						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	< LOD
Reading:	42	**Reading:**	< LOD

5/9/2013 0822

Readings:	2536	2512	2143	2566	1954	2602	2491
Std Conc.:	2700						
Std Deviation:	249						
Mean Conc.:	2401						
RSD:	10.38						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	< LOD
Reading:	54	**Reading:**	< LOD

5/9/2013 1800

Readings:	2567	2513	2558	2475	2540	2614	2480
Std Conc.:	2700						
Std Deviation:	50						
Mean Conc.:	2535						
RSD:	1.97						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	< LOD
Reading:	49	**Reading:**	< LOD

5/10/2013 0730

Readings:	2566	2581	2533	2621	2589	2488	2550
Std Conc.:	2700						
Std Deviation:	43						
Mean Conc.:	2561						
RSD:	1.68						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	< LOD
Reading:	38	**Reading:**	< LOD

5/10/2013 1300

Readings:	2553	2516	2620	2507	2511	2556	2550
Std Conc.:	2700						
Std Deviation:	39						
Mean Conc.:	2545						
RSD:	1.55						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	< LOD
Reading:	56	**Reading:**	< LOD

Date/Time								
6/11/2013 0810	**Readings:**	2722	2602	2605	2662	2555	2606	2556
	Std Conc.:	2700						
	Std Deviation:	59						
	Mean Conc.:	2615						
	RSD:	2.27						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	<LOD
Reading:	47	**Reading:**	<LOD

Date/Time								
6/11/2013 1330	**Readings:**	2633	2643	2702	2598	2610	2598	2555
	Std Conc.:	2700						
	Std Deviation:	46						
	Mean Conc.:	2620						
	RSD:	1.76						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	<LOD
Reading:	57	**Reading:**	<LOD

Date/Time								
6/12/2013 0810	**Readings:**	2663	2605	2649	2727	2631	2482	2651
	Std Conc.:	2700						
	Std Deviation:	75						
	Mean Conc.:	2630						
	RSD:	2.86						

Standard:	Till 4		Blank
Std. Conc.:	50	**Std. Conc.:**	<LOD
Reading:	41	**Reading:**	<LOD

Date/Time								
12/2/2013 1221	**Readings:**	485	468	477	462	514	485	468
	Std Conc.:	500						
	Std Deviation:	17						
	Mean Conc.:	480						
	RSD:	3.64						

Standard:	GBW		Till 4		Blank
Std. Conc.:	2700	**Std. Conc.:**	50	**Std. Conc.:**	<LOD
Reading:	2665	**Reading:**	45	**Reading:**	<LOD

Date/Time								
12/3/2013 1221	**Readings:**	481	479	484	467	472	482	460
	Std Conc.:	500						
	Std Deviation:	9						
	Mean Conc.:	475						
	RSD:	1.88						

Standard:	GBW		Till 4		Blank
Std. Conc.:	2700	**Std. Conc.:**	50	**Std. Conc.:**	<LOD
Reading:	2622	**Reading:**	42	**Reading:**	<LOD

Date/Time								
12/4/2013 1221	**Readings:**	480	470	429	476	457	490	463
	Std Conc.:	500						
	Std Deviation:	20						
	Mean Conc.:	466						
	RSD:	4.24						

Standard:	GBW		Till 4		Blank
Std. Conc.:	2700	**Std. Conc.:**	50	**Std. Conc.:**	<LOD
Reading:	2710	**Reading:**	36	**Reading:**	<LOD

Date/Time								
12/4/2013 1221	**Readings:**	487	512	476	509	463	475	433
	Std Conc.:	500						
	Std Deviation:	27						
	Mean Conc.:	479						
	RSD:	5.68						

Standard:	GBW		Till 4		Blank
Std. Conc.:	2700	**Std. Conc.:**	50	**Std. Conc.:**	<LOD
Reading:	2595	**Reading:**	35	**Reading:**	<LOD

Notes: - Precision calibration must be done prior to beginning work each day.
- The RSD must be less than 20% to pass.

APPENDIX D

EPA SAMPLE FIELD SHEETS AND CHAIN OF CUSTODY RECORDS

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Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 1 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-1-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-9C-24-30

External Sample Number: CCR-SS-9C-24-30

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	05/08/13	08:05
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	'4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 2 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-2-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-9B.42-48

External Sample Number: CCR-SS-9B-42-48

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/08/13 09:10
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 3 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-3-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SO-9A-0-6

External Sample Number: CCR-SO-9A-0-6

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/08/13 09:50

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 4 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-4-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-10C-6-12

External Sample Number: CCR-SS-10C-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/08/13 13:45

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 5 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-5-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-10B-6-12

External Sample Number: CCR-SS-10B-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/08/13 14:15

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 6 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-6-__

Project ID: EC073708
Project Manager: Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County
State: Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS
Site ID: 0737 **Site OU:** 08

Location Desc: CCR-SD-10A-0-6

External Sample Number: CCR-SD-10A-0-6

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	05/08/13	15:00
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 7 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-7-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-8B-6-12

External Sample Number: CCR-SS-8B-6-12

Expected Conc:	(or Circle One: Low Medium High)		**Date**	**Time(24 hr)**
Latitude:	___ ___ ___	**Sample Collection: Start:**	05/08/13	17:15
Longitude:	___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 8 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-8-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-8A-12-18

External Sample Number: CCR-SS-8A-12-18

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	05/08/13	18:00
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 9 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-9-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-5BN-6-12

External Sample Number: CCR-SS-5BN-6-12

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	05/09/13	09:00
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 10 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-10-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-5A-12-18

External Sample Number: CCR-SS-5A-12-18

Expected Conc: (or Circle One: Low Medium High)

			Date	Time(24 hr)
Latitude:	___ ___ ___	**Sample Collection: Start:**	05/09/13	09:30
Longitude:	___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 11 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-11-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-3A-6-12

External Sample Number: CCR-SS-3A-6-12

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: __ __ __	**Sample Collection: Start:**	~~09~~ 05/09/13	10:10
Longitude: __ __ __	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 12 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-12-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-4A-18-24

External Sample Number: CCR-SS-4A-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/09/13 11:50

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 13 **QC Code:** FD **Matrix:** Solid **Tag ID:** 6105-~~13~~ 12 -AP

Project ID: EC073708
Project Manager: Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County
State: Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS
Site ID: 0737 **Site OU:** 08

Location Desc: CCR-SS-4A-18-24

External Sample Number: CCR-SS-4A-18-24

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	05/09/13	11:50
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Field duplicate of 6105-12

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 14 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-14-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-3B-30-36

External Sample Number: CCR-SS-3B-30-36

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/09/13 14:15

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 15 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-15-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-7B-6-12

External Sample Number: CCR-SS-7B-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/09/13 15:30

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 16 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-16-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-7A-12-18

External Sample Number: CCR-SS-7A-12-18

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	05/09/13	16:30
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 17 **QC Code:** FD **Matrix:** Solid **Tag ID:** 6105-~~17~~ 16 AP-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-7A-12-18 Duplicate

External Sample Number: CCR-SS-7A-12-18 Duplicate

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/09/10 16:30

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A) Field Duplicate

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 18 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-18-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-15B-6-12

External Sample Number: CCR-SS-15B-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/10/13 09:19

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 19 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-19-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SO-15A-0-6

External Sample Number: CCR-SO-15A-0-6

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/10/13 10:20

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 20 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-20-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-13A-6-12

External Sample Number: CCR-SS-13A-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/10/13 11:30

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 21 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-21-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SO-16B-0-6

External Sample Number: CCR-SO-16B-0-6

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 05/10/13 14:40
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet

US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 22 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-22-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SO-16A-0-6

External Sample Number: CCR-SO-16A-0-6

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: __ __ __	**Sample Collection: Start:**	05/10/13	14:45
Longitude: __ __ __	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 23 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-23-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-20A 36-42

External Sample Number: CCR-SS-20A-36-42

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 6/11/13 15:00

Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 20A, 36-42 in bgs

Duplicate collected

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 23 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-23-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-20A 36-42

External Sample Number: CCR-SS-20A-36-42

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 6/11/13 15:00
Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 20A, 36-42 in bgs

Duplicate collected

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 24 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-24-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: ~~18A-24-30~~ CCRSS-18A-24-30

External Sample Number: CCR-SS-18A-24-30

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: __ __ __	**Sample Collection: Start:**	6/11/13	13:00
Longitude: __ __ __	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 18A 24-30in bgs

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 25 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-25-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-17C 12-18

External Sample Number: CCR-SS-17C-12-18

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	6/11/13	09:25
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 17C 12-18in bgs

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 26 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-26-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-17B 18-24

External Sample Number: CCR-SS-17B-18-24

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: __ __ __	**Sample Collection: Start:**	6/11/13	11:00
Longitude: __ __ __	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

17B 18-24 in bgs

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 27 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-27-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-20B-12-18

External Sample Number: CCR-SS-20B-12-18

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	6/11/13	15:30
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 20B 12-18 in bgs

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 28 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-28-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS- 19A 36-42

External Sample Number: CCR-SS-19A-36-42

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: __ __ __	**Sample Collection: Start:**	6/11/13	14:20
Longitude: __ __ __	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 19A 36-42 in bgs

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 29 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-29-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-17A 12-18

External Sample Number: CCR-SS-17A-12-18

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	6/11/13	11:10
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

17A 12-18 in bgs

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 30 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-30-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS21C 6-12

External Sample Number: CCR-SS-21C-6-12

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	6/12/13	09:00
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 21C 6-12 in bgs

Duplicate Collected

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 30 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-30-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS21C 6-12

External Sample Number: CCR-SS-21C-6-12

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	6/12/13	09:00
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Location 21C 6-12 in bgs

Duplicate Collected

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 31 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-31-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS ~~-12-18~~ -21B-12-18

External Sample Number: CCR-SS-21B-12-18

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 6/12/13 11:00

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 32 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-32-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-~~22A~~ - SS-22A-30-36

External Sample Number: CCR-SS-22A-30-36

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 6/12/13 11:30

Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 33 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-33-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR - SS - ~~24~~ 21A - 24-30

External Sample Number: CCR-SS-21A-24-30

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 6/12/13 12:30

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 34 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-34-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-23B-18-24

External Sample Number: CCR-SS-23B-18-24

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: __ __ __	**Sample Collection: Start:**	6/12/13	13:30
Longitude: __ __ __	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 35 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-35-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-22A-36-42

External Sample Number: CCR-SS-22A-36-42

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 6/12/13 13:40

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 36 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-36-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-1A-0-6

External Sample Number: CCR-SS-1A-0-6

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/02/13 14:55

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 37 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-37-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-1B-18-24

External Sample Number: CCR-SS-1B-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/02/13 14:35

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 38 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-38-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-1C-24-30

External Sample Number: CCR-SS-1C-24-30

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 14:12

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 39 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-39-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-2A-6-12

External Sample Number: CCR-SS-2A-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/03/13 16:12
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 40 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-40-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-6A-6-12

External Sample Number: CCR-SS-6A-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/02/13 17:15

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 41 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-41-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-6B-18-24

External Sample Number: CCR-SS-6B-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/02/13 16:51

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 42 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-42-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-24B-6-12

External Sample Number: CCR-SS-24B-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 12/03/13 08:57
Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 43 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-43-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-24A-24-30

External Sample Number: CCR-SS-24A-24-30

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: __ __ __	**Sample Collection: Start:**	12/03/13	09:36
Longitude: __ __ __	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 44 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-44-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-25B-0-6

External Sample Number: CCR-SS-25B-0-6

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/03/13 09:49
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 45 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-45-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-25A-6-12

External Sample Number: CCR-SS-25A-6-12

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	12/03/13	11:08
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 46 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-46-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-26B-18-24

External Sample Number: CCR-SS-26B-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/03/13 11:52

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 47 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-47-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-26A-0-6

External Sample Number: CCR-SS-26A-0-6

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/03/13 12:18
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 48 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-48-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-27B-12-18

External Sample Number: CCR-SS-27B-12-18

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	12/03/13	14:07
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 49 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-49-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-27A-6-12

External Sample Number: CCR-SS-27A-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/02/13 14:50
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 50 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-50-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCK-SS-28B-6-12

External Sample Number: CCK-SS-28B-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 12/03/13 15:28
Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time		Analysis
1 - 8 oz glass	4 Deg C	180	Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 51 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-51-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-28A-6-12

External Sample Number: CCR-SS-28A-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/03/13 16:26

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 52 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-52-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCK-SS-29B-18-24

External Sample Number: CCK-SS-29B-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 12/03/13 17:16

Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 53 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-53-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-30A-18-24

External Sample Number: CCR-SS-30A-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 07:55
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 54 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-54-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-30B-12-18

External Sample Number: CCR-SS-30B-12-18

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	12/04/13	08:04
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 55 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-55-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-29A-18-24

External Sample Number: CCR-SS-29A-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 12/04/13 08:06

Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 56 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-56-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-31B-12-18

External Sample Number: CCR-SS-31B-12-18

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 08:17
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:
(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 57 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-57-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-31A-18-24

External Sample Number: CCR-SS-31A-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 08:55
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 58 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-~~58~~-__ 57-FD
12/5/13

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-31A-18-24-D

External Sample Number: CCK-SS-31A-18-24-D

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	12/04/13	08:55
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 59 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-59-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-33A-6-12

External Sample Number: CCR-SS-33A-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 12/04/13 09:44
Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 60 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-~~60~~- 59-FD MF 12/5/13

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-33A-6-12-D

External Sample Number: CCR-SS-33A-6-12-D

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 09:44

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 61 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-61-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCK-SS-33B-6-12

External Sample Number: CCK-SS-33B-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** ~~0~~12/04/13 10:11

Longitude: ___ ___ ___ **End:** AF 12/5/13 __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 62 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-~~62~~-61-FD MF 12/5/13

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-33B-6-12-D

External Sample Number: CCR-SS-33B-6-12-D

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 10:11

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 63 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-63-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-32A-18-24

External Sample Number: CCR-SS-32A-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 10:58

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 64 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-~~64~~-63-FD
AE 12/5/13

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCK-SS-32A-18-24-D

External Sample Number: CCK-SS-32A-18-24-D

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 10:58
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 65 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-65-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-32B-12-18

External Sample Number: CCR-SS-32B-12-18

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 12:34

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time		Analysis
1 - 8 oz glass	4 Deg C	180	Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 66 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-66-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-13E-18-24

External Sample Number: CCR-SS-13E-18-24

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: __ __ __ **Sample Collection: Start:** 12/04/13 14:08

Longitude: __ __ __ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 67 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-~~67~~-66-FD AF 12/5/13

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-13E-18-24-D

External Sample Number: CCR-SS-13E-18-24-D

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 14:08
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 68 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-68-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-13C-12-18

External Sample Number: CCR-SS-13C-12-18

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/04/13 13:25

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 69 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-69-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-13B-18-24

External Sample Number: CCR-SS-13B-18-24

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	~~12/04/13~~ 12/05/13 AF 12/5/13	09:02
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 70 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-70-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-13D-6-12

External Sample Number: CCR-SS-13D-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/05/13 09:29
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 71 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-71-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-12A-12-18

External Sample Number: CCR-SS-12A-12-18

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/05/13 10:09

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 72 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-72-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-12B-0-6

External Sample Number: CCR-SS-12B-0-6

Expected Conc: (or Circle One: Low Medium High)

		Date	Time(24 hr)
Latitude: ___ ___ ___	**Sample Collection: Start:**	12/05/13	11:00
Longitude: ___ ___ ___	**End:**	__/__/__	__:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 73 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-73-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-11A-0-6

External Sample Number: CCR-SS-11A-0-6

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/05/13 11:27
Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

Sample Collection Field Sheet
US EPA Region 7
Kansas City, KS

ASR Number: 6105 **Sample Number:** 74 **QC Code:** __ **Matrix:** Solid **Tag ID:** 6105-74-__

Project ID: EC073708 **Project Manager:** Elizabeth Coffey
Project Desc: Cherokee County - Railroads
City: Cherokee County **State:** Kansas
Program: Superfund
Site Name: CHEROKEE COUNTY - RAILROADS **Site ID:** 0737 **Site OU:** 08

Location Desc: CCR-SS-13A-6-12

External Sample Number: CCR-SS-13A-6-12

Expected Conc: (or Circle One: Low Medium High) **Date** **Time(24 hr)**

Latitude: ___ ___ ___ **Sample Collection: Start:** 12/05/13 12:01

Longitude: ___ ___ ___ **End:** __/__/__ __:__

Laboratory Analyses:

Container	Preservative	Holding Time	Analysis
1 - 8 oz glass	4 Deg C	180 Days	1 Metals in Solids by ICP-AES

Sample Comments:

(N/A)

Sample Collected By: HGL

CHAIN OF CUSTODY RECORD
ENVIRONMENTAL PROTECTION AGENCY REGION VII

ACTIVITY LEADER(Print)	NAME OF SURVEY OR ACTIVITY	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET
E. Coffey	Cherokee County Railroads	11-12 / 6 / 2013	1 of 1

CONTENTS OF SHIPMENT

SAMPLE NUMBER	CUBITAINER	8oz BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
6105-23		1					X				
6105-23-FD		1					X				
6105-24		1					X				
6105-25		1					X				
6105-26		1					X				
6105-27		1					X				
6105-28		1					X				
6105-29		1					X				
6105-30		1					X				
6105-30-FD		1					X				
6105-31		1					X				
6105-32		1					X				
6105-33		1					X				
6105-34		1					X				
6105-35		1					X				

NUMBERS OF CONTAINERS PER SAMPLE NUMBER

ASR Incomplete

DESCRIPTION OF SHIPMENT

15 PIECE(S) CONSISTING OF F BOX(ES)

ICE CHEST(S): OTHER

MODE OF SHIPMENT

COMMERCIAL CARRIER:
COURIER
X SAMPLER CONVEYED
(SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
[signature] SEALED ☐ UNSEALED ☒	6-13-13	0930	SEALED ☐ UNSEALED ☐	
RELINQUISHED BY — SEALED ☐ UNSEALED ☐	DATE	TIME	RECEIVED BY — SEALED ☐ UNSEALED ☐	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY — SEALED ☐ UNSEALED ☐	DATE	TIME	RECEIVED BY — SEALED ☐ UNSEALED ☐	REASON FOR CHANGE OF CUSTODY

CHAIN OF CUSTODY RECORD
ENVIRONMENTAL PROTECTION AGENCY REGION VII

ASR Complete

ACTIVITY LEADER(Print)	NAME OF SURVEY OR ACTIVITY	DATE OF COLLECTION	SHEET
Elizabeth Coffey	Cherokee County - Railroads	DAY 02-05 MONTH 12 YEAR 13	1 of 2

CONTENTS OF SHIPMENT

SAMPLE NUMBER	CUBITAINER	8oz BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
6105-36		1					X				
6105-37		1					X				
6105-38		1					X				
6105-39		1					X				
6105-40		1					X				
6105-41		1					X				
6105-42		1					X				
6105-43		1					X				
6105-44		1					X				
6105-45		1					X				
6105-46		1					X				
6105-47		1					X				
6105-48		1					X				
6105-49		1					X				
6105-50		1					X				
6105-51		1					X				
6105-52		1					X				
6105-53		1					X				
6105-54		1					X				
6105-55		1					X				
6105-56		1					X				
6105-57		1					X				
6105-57FD		1					X				Field duplicate
6105-59		1					X				

NUMBERS OF CONTAINERS PER SAMPLE NUMBER

DESCRIPTION OF SHIPMENT	MODE OF SHIPMENT
____ PIECE(S) CONSISTING OF ____ BOX(ES)	____ COMMERCIAL CARRIER: ____
____ ICE CHEST(S); OTHER ____	____ COURIER
	____ SAMPLER CONVEYED ____ (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
[signature] ☐ SEALED UNSEALED ☐	12/5/2013	13:45	RD Wiggains ☐ SEALED UNSEALED ☒	Rec'd at lab
RELINQUISHED BY ☐ SEALED UNSEALED ☐	DATE	TIME	RECEIVED BY ☐ SEALED UNSEALED ☐	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY ☐ SEALED UNSEALED ☐	DATE	TIME	RECEIVED BY ☐ SEALED UNSEALED ☐	REASON FOR CHANGE OF CUSTODY

*U.S. GPO: 2002-756-917/40053

CHAIN OF CUSTODY RECORD
ENVIRONMENTAL PROTECTION AGENCY REGION VII

ACTIVITY LEADER(Print)	NAME OF SURVEY OR ACTIVITY	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET
Elizabeth Coffey	Cherokee County-Railroads	02-05 / 12 / 13	2 of 2

CONTENTS OF SHIPMENT

SAMPLE NUMBER	CUBITAINER	8 oz BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
6105-59-FD		1					X				Field duplicate
6105-61		1					X				
6105-61-FD		1					X				Field duplicate
6105-63		1					X				
6105-63-FD		1					X				Field duplicate
6105-65		1					X				
6105-66		1					X				
6105-66-FD		1					X				Field duplicate
6105-68		1					X				
6105-69		1					X				
6105-70		1					X				
6105-71		1					X				
6105-72		1					X				
6105-73		1					X				
6105-74		1					X				

NUMBERS OF CONTAINERS PER SAMPLE NUMBER

ASK Complete

DESCRIPTION OF SHIPMENT

_____ PIECE(S) CONSISTING OF _____ BOX(ES)

_____ ICE CHEST(S): OTHER _____

MODE OF SHIPMENT

_____ COMMERCIAL CARRIER: _____

_____ COURIER

_____ SAMPLER CONVEYED _____ (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
[signature] SEALED / UNSEALED	12/5/13	1345	R.W. Wiggans SEALED / UNSEALED	Rec'd at lab
RELINQUISHED BY: SEALED / UNSEALED	DATE	TIME	RECEIVED BY: SEALED / UNSEALED	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY: SEALED / UNSEALED	DATE	TIME	RECEIVED BY: SEALED / UNSEALED	REASON FOR CHANGE OF CUSTODY

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APPENDIX E

DATA CORRELATION REGRESSION ANALYSIS

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Appendix E
Laboratory vs XRF Sample Result Correlation
Cherokee County Superfund Site OU8

Sample Number	Lab Lead Result	XRF Lead Average	Location_Desc
6105-1	225	252.3	CCR-SS-9C (24-30)
6105-2	24.6	99.7	CCR-SS-9B (42-48)
6105-3	369	364	CCR-SO-9A (0-6)
6105-4	152	119	CCR-SS-10C (6-12)
6105-5	338	364	CCR-SS-10B (6-12)
6105-6	398	640.3	CCR-SO-10A (0-6)
6105-7	906	329.7	CCR-SS-8B (6-12)
6105-8	266	236	CCR-SS-8A (12-18)
6105-9	3260	2008.7	CCR-SS-5BN (6-12)
6105-10	837	838	CCR-SS-5A (12-18)
6105-11	417	292	CCR-SS-3A (6-12)
6105-12-FD	257	225.7	CCR-SS-4A (18-24)
6105-12	193	225.7	CCR-SS-4A (18-24)
6105-14	61.5	71.0	CCR-SS-3B (30-36)
6105-15	270	235.3	CCR-SS-7B (6-12)
6105-16-FD	361	365.3	CCR-SS-7A (12-18)
6105-16	510	365.3	CCR-SS-7A (12-18)
6105-18	556	443.3	CCR-SS-15B (6-12)
6105-19	461	327.7	CCR-SO-15A (0-6)
6105-20	149	145	CCR-SS-13A-L (6-12)
6105-21	265	157.7	CCR-SO-16B (0-6)
6105-22	528	412	CCR-SO-16A (0-6)
6105-23-FD	198	113.7	CCR-SS-20A (36-42)
6105-23	240	113.7	CCR-SS-20A (36-42)
6105-24	53.8	18.3	CCR-SS-18A (24-30)
6105-25	288	371.3	CCR-SS-17C (12-18)
6105-26	78	115.3	CCR-SS-17B (18-24)
6105-27	58.1	131	CCR-SS-20B (12-18)
6105-28	74.8	49.3	CCR-SS-19A (36-42)
6105-29	1050	986.7	CCR-SS-17A (12-18)
6105-30-FD	981	1150.7	CCR-SS-21C (6-12)
6105-30	916	1150.7	CCR-SS-21C (6-12)
6105-31	468	599.7	CCR-SS-21B (12-18)
6105-32	7.3	18.5	CCR-SS-22A (30-36)
6105-33	364	262.3	CCR-SS-21A (24-30)
6105-34	123	135.7	CCR-SS-23B (18-24)
6105-35	22.7	25.0	CCR-SS-22A (36-42)
6105-36	490	576.7	CCR-SS-1A (0-6)
6105-37	266	403	CCR-SS-1B (18-24)
6105-38	475	242.3	CCR-SS-1C (24-30)
6105-39	1940	2076.7	CCR-SS-2A (6-12)

Appendix E (Continued)
Laboratory vs XRF Sample Result Correlation
Cherokee County Superfund Site OU8

Sample Number	Lab Lead Result	XRF Lead Average	Location_Desc
6105-40	322	495.3	CCR-SS-6A (6-12)
6105-41	76.6	656.7	CCR-SS-6B (18-24)
6105-42	609	1198.7	CCR-SS-24B (6-12)
6105-43	86.0	98.0	CCR-SS-24A (24-30)
6105-44	386	397	CCR-SS-25B (0-6)
6105-45	1960	1657.3	CCR-SS-25A (6-12)
6105-46	472	448.3	CCR-SS-26B (18-24)
6105-47	884	701	CCR-SS-26A (0-6)
6105-48	429	484.7	CCR-SS-27B (12-18)
6105-49	4260	1427.7	CCR-SS-27A (6-12)
6105-50	392	441.3	CCR-SS-28B (6-12)
6105-51	466	611	CCR-SS-28A (6-12)
6105-52	403	324.3	CCR-SS-29B (18-24)
6105-53	2310	1706.3	CCR-SS-30A (18-24)
6105-54	1500	1582	CCR-SS-30B (12-18)
6105-55	380	422.3	CCR-SS-29A (18-24)
6105-56	476	491.7	CCR-SS-31B (12-18)
6105-57-FD	3340	1355.3	CCR-SS-31A (18-24)
6105-57	3600	1355.3	CCR-SS-31A (18-24)
6105-59-FD	880	686	CCR-SS-33A (6-12)
6105-59	727	686	CCR-SS-33A (6-12)
6105-61-FD	737	746.7	CCR-SS-33B (6-12)
6105-61	887	746.7	CCR-SS-33B (6-12)
6105-63-FD	1320	931.7	CCR-SS-32A (18-24)
6105-63	1150	931.7	CCR-SS-32A (18-24)
6105-65	1260	1060	CCR-SS-32B (12-18)
6105-66-FD	178	425.7	CCR-SS-13E (18-24)
6105-66	329	425.7	CCR-SS-13E (18-24)
6105-68	1390	1530.7	CCR-SS-13C (12-18)
6105-69	1640	1641	CCR-SS-13B (18-24)
6105-70	3750	2254.7	CCR-SS-13D (6-12)
6105-71	300	596.3	CCR-SS-12A (12-18)
6105-72	457	478	CCR-SS-12B (0-6)
6105-73	827	572.7	CCR-SS-11A (0-6)
6105-74	820	822.7	CCR-SS-13A-B (6-12)

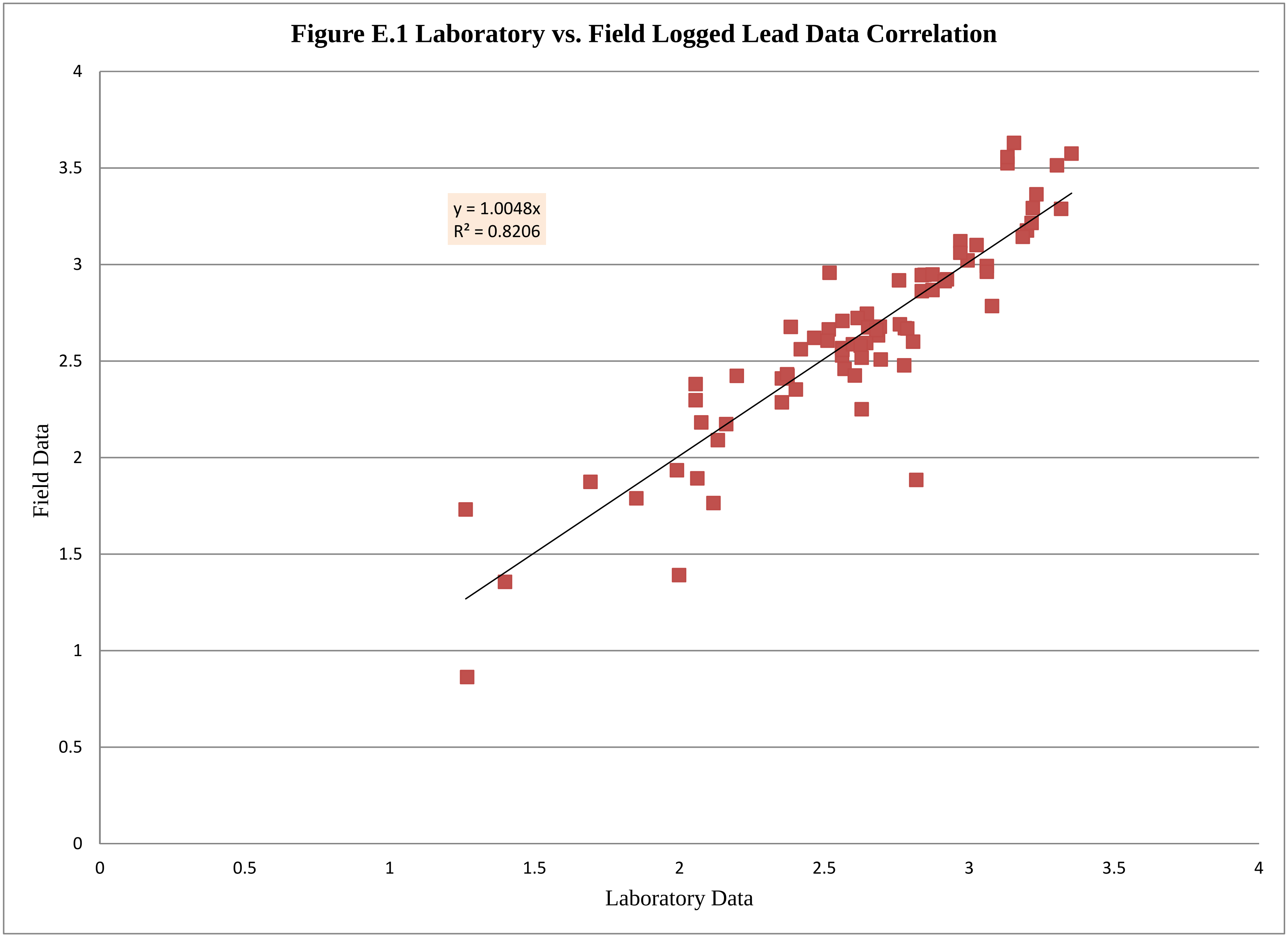
Figure E.1 Laboratory vs. Field Logged Lead Data Correlation
y = 1.0048x
R² = 0.8206
Field Data
Laboratory Data
0
0.5
1
1.5
2
2.5
3
3.5
4

APPENDIX F

EPA LABORATORY ANALYTICAL DATA PACKAGE

(Provided on CD)

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United States Environmental Protection Agency
Region 7
300 Minnesota Avenue
Kansas City, KS 66101

Date: 01/09/2014

Subject: Transmittal of Sample Analysis Results for ASR #: 6105

Project ID: EC073708

Project Description: Cherokee County - Railroads

From: Michael F. Davis, Chief
Chemical Analysis and Response Branch, Environmental Services Division

To: Elizabeth Coffey
SUPR/SPEB

Enclosed are the analytical data for the above-referenced Analytical Services Request (ASR) and Project. The Regional Laboratory has reviewed and verified the results in accordance with procedures described in our Quality Manual (QM). In addition to all of the analytical results, this transmittal contains pertinent information that may have influenced the reported results and documents any deviations from the established requirements of the QM.

Please contact us within 14 days of receipt of this package if you determine there is a need for any changes. Please complete the enclosed Customer Satisfaction Survey and Data Disposition/Sample Release memo for this ASR as soon as possible. The process of disposing of the samples for this ASR will be initiated 30 days from the date of this transmittal unless an alternate release date is specified on the Data Disposition/Sample Release memo.

If you have any questions or concerns relating to this data package, contact our customer service line at 913-551-5295.

Enclosures

cc: Analytical Data File.

Project Manager:	Elizabeth Coffey	Org:	SUPR/SPEB	Phone:	913-551-7939
Project ID:	EC073708			QAPP Number:	2007197
Project Desc:	Cherokee County - Railroads				
Location:	Cherokee County	State:	Kansas	Program:	Superfund
Site Name:	CHEROKEE COUNTY - RAILROADS			Site ID:	0737 Site OU: 08
Purpose:	Site Characterization			GPRA PRC:	303DD2

Explanation of Codes, Units and Qualifiers used on this report

Sample QC Codes: QC Codes identify the type of sample for quality control purpose.

__ = Field Sample
FD = Field Duplicate

Units: Specific units in which results are reported.

mg/kg = Milligrams per Kilogram

Data Qualifiers: Specific codes used in conjunction with data values to provide additional information on the quality of reported results, or used to explain the absence of a specific value.

(Blank) = Values have been reviewed and found acceptable for use.
U = The analyte was not detected at or above the reporting limit.
J = The identification of the analyte is acceptable; the reported value is an estimate.

Project ID: EC073708 Project Desc: Cherokee County - Railroads

Sample No	QC Code	Matrix	Location Description	External Sample No	Start Date	Start Time	End Date	End Time	Receipt Date
1 -	__	Solid	CCR-SS-9C (24-30)		05/08/2013	08:05			05/14/2013
2 -	__	Solid	CCR-SS-9B (42-48)		05/08/2013	09:10			05/14/2013
3 -	__	Solid	CCR-SO-9A (0-6)		05/08/2013	09:50			05/14/2013
4 -	__	Solid	CCR-SS-10C (6-12)		05/08/2013	13:45			05/14/2013
5 -	__	Solid	CCR-SS-10B (6-12)		05/08/2013	14:15			05/14/2013
6 -	__	Solid	CCR-SO-10A (0-6)		05/08/2013	15:00			05/14/2013
7 -	__	Solid	CCR-SS-8B (6-12)		05/08/2013	17:15			05/14/2013
8 -	__	Solid	CCR-SS-8A (12-18)		05/08/2013	18:00			05/14/2013
9 -	__	Solid	CCR-SS-5BN (6-12)		05/09/2013	09:00			05/14/2013
10 -	__	Solid	CCR-SS-5A (12-18)		05/09/2013	09:30			05/14/2013
11 -	__	Solid	CCR-SS-3A (6-12)		05/09/2013	10:10			05/14/2013
12 -	__	Solid	CCR-SS-4A (18-24)		05/09/2013	11:50			05/14/2013
12 -	FD	Solid	CCR-SS-4A (18-24)		05/09/2013	11:50			05/14/2013
14 -	__	Solid	CCR-SS-3B (30-36)		05/09/2013	14:15			05/14/2013
15 -	__	Solid	CCR-SS-7B (6-12)		05/09/2013	15:30			05/14/2013
16 -	__	Solid	CCR-SS-7A (12-18)		05/09/2013	16:30			05/14/2013
16 -	FD	Solid	CCR-SS-7A (12-18)		05/09/2013	16:30			05/14/2013
18 -	__	Solid	CCR-SS-15B (6-12)		05/10/2013	09:19			05/14/2013
19 -	__	Solid	CCR-SO-15A (0-6)		05/10/2013	10:20			05/14/2013
20 -	__	Solid	CCR-SS-13A (6-12)		05/10/2013	11:30			05/14/2013
21 -	__	Solid	CCR-SO-16B (0-6)		05/10/2013	14:40			05/14/2013
22 -	__	Solid	CCR-SO-16A (0-6)		05/10/2013	14:45			05/14/2013
23 -	__	Solid	CCR-SS-20A (36-42)		06/11/2013	15:00			06/13/2013
23 -	FD	Solid	CCR-SS-20A (36-42)		06/11/2013	15:00			06/13/2013
24 -	__	Solid	CCR-SS-18A (24-30)		06/11/2013	13:00			06/13/2013
25 -	__	Solid	CCR-SS-17C (12-18)		06/11/2013	09:25			06/13/2013
26 -	__	Solid	CCR-SS-17B (18-24)		06/11/2013	11:00			06/13/2013
27 -	__	Solid	CCR-SS-20B (12-18)		06/11/2013	15:30			06/13/2013
28 -	__	Solid	CCR-SS-19A (36-42)		06/11/2013	14:20			06/13/2013
29 -	__	Solid	CCR-SS-17A (12-18)		06/11/2013	11:10			06/13/2013
30 -	__	Solid	CCR-SS-21C (6-12)		06/12/2013	09:00			06/13/2013
30 -	FD	Solid	CCR-SS-21C (6-12)		06/12/2013	09:00			06/13/2013
31 -	__	Solid	CCR-SS-21B (12-18)		06/12/2013	11:00			06/13/2013
32 -	__	Solid	CCR-SS-22A (30-36)		06/12/2013	11:30			06/13/2013
33 -	__	Solid	CCR-SS-21A (24-30)		06/12/2013	12:30			06/13/2013
34 -	__	Solid	CCR-SS-23B (18-24)		06/12/2013	13:30			06/13/2013
35 -	__	Solid	CCR-SS-22A (36-42)		06/12/2013	13:40			06/13/2013
36 -	__	Solid	CCR-SS-1A (0-6)		12/02/2013	14:55			12/05/2013
37 -	__	Solid	CCR-SS-1B (18-24)		12/02/2013	14:35			12/05/2013
38 -	__	Solid	CCR-SS-1C (24-30)		12/02/2013	14:12			12/05/2013
39 -	__	Solid	CCR-SS-2A (6-12)		12/02/2013	16:12			12/05/2013
40 -	__	Solid	CCR-SS-6A (6-12)		12/02/2013	17:15			12/05/2013
41 -	__	Solid	CCR-SS-6B (18-24)		12/02/2013	16:51			12/05/2013
42 -	__	Solid	CCR-SS-24B (6-12)		12/03/2013	08:57			12/05/2013

Sample No	QC Code	Matrix	Location Description	External Sample No	Start Date	Start Time	End Date	End Time	Receipt Date
43 -	__	Solid	CCR-SS-24A (24-30)		12/03/2013	09:36			12/05/2013
44 -	__	Solid	CCR-SS-25B (0-6)		12/03/2013	09:49			12/05/2013
45 -	__	Solid	CCR-SS-25A (6-12)		12/03/2013	11:08			12/05/2013
46 -	__	Solid	CCR-SS-26B (18-24)		12/03/2013	11:52			12/05/2013
47 -	__	Solid	CCR-SS-26A (0-6)		12/03/2013	12:18			12/05/2013
48 -	__	Solid	CCR-SS-27B (12-18)		12/03/2013	14:07			12/05/2013
49 -	__	Solid	CCR-SS-27A (6-12)		12/03/2013	14:50			12/05/2013
50 -	__	Solid	CCR-SS-28B (6-12)		12/03/2013	15:28			12/05/2013
51 -	__	Solid	CCR-SS-28A (6-12)		12/03/2013	16:26			12/05/2013
52 -	__	Solid	CCR-SS-29B (18-24)		12/03/2013	17:16			12/05/2013
53 -	__	Solid	CCR-SS-30A (18-24)		12/04/2013	07:55			12/05/2013
54 -	__	Solid	CCR-SS-30B (12-18)		12/04/2013	08:04			12/05/2013
55 -	__	Solid	CCR-SS-29A (18-24)		12/04/2013	08:06			12/05/2013
56 -	__	Solid	CCR-SS-31B (12-18)		12/04/2013	08:17			12/05/2013
57 -	__	Solid	CCR-SS-31A (18-24)		12/04/2013	08:55			12/05/2013
57 -	FD	Solid	CCR-SS-31A (18-24)		12/04/2013	08:55			12/05/2013
59 -	__	Solid	CCR-SS-33A (6-12)		12/04/2013	09:44			12/05/2013
59 -	FD	Solid	CCR-SS-33A (6-12)		12/04/2013	09:44			12/05/2013
61 -	__	Solid	CCR-SS-33B (6-12)		12/04/2013	10:11			12/05/2013
61 -	FD	Solid	CCR-SS-33B (6-12)		12/04/2013	10:11			12/05/2013
63 -	__	Solid	CCR-SS-32A (18-24)		12/04/2013	10:58			12/05/2013
63 -	FD	Solid	CCR-SS-32A (18-24)		12/04/2013	10:58			12/05/2013
65 -	__	Solid	CCR-SS-32B (12-18)		12/04/2013	12:34			12/05/2013
66 -	__	Solid	CCR-SS-13E (18-24)		12/04/2013	14:08			12/05/2013
66 -	FD	Solid	CCR-SS-13E (18-24)		12/04/2013	14:08			12/05/2013
68 -	__	Solid	CCR-SS-13C (12-18)		12/04/2013	13:25			12/05/2013
69 -	__	Solid	CCR-SS-13B (18-24)		12/05/2013	09:02			12/05/2013
70 -	__	Solid	CCR-SS-13D (6-12)		12/05/2013	09:29			12/05/2013
71 -	__	Solid	CCR-SS-12A (12-18)		12/05/2013	10:09			12/05/2013
72 -	__	Solid	CCR-SS-12B (0-6)		12/05/2013	11:00			12/05/2013
73 -	__	Solid	CCR-SS-11A (0-6)		12/05/2013	11:27			12/05/2013
74 -	__	Solid	CCR-SS-13A (6-12)		12/05/2013	12:01			12/05/2013

Analysis	Comments About Results For This Analysis

1 Metals in Solids by ICP-AES

Lab: Contract Lab Program (Out-Source)

Method: CLP Statement of Work

Basis: Dry

Samples:

1-__	2-__	3-__	4-__	5-__	6-__	7-__
8-__	9-__	10-__	11-__	12-__	12-FD	14-__
15-__	16-__	16-FD	18-__	19-__	20-__	21-__
22-__	23-__	23-FD	24-__	25-__	26-__	27-__
28-__	29-__	30-__	30-FD	31-__	32-__	33-__
34-__	35-__	36-__	37-__	38-__	39-__	40-__
41-__	42-__	43-__	44-__	45-__	46-__	47-__
48-__	49-__	50-__	51-__	52-__	53-__	54-__
55-__	56-__	57-__	57-FD	59-__	59-FD	61-__
61-FD	63-__	63-FD	65-__	66-__	66-FD	68-__
69-__	70-__	71-__	72-__	73-__	74-__	

Comments:

Slight cadmium contamination was found in the calibration blanks. Only samples containing this analyte at a level greater than ten times the contamination level of the blank are reported without being qualified. All samples that contained this analyte but at a level less than ten times the contamination in the blank have the result U-coded indicating that the reporting limit has been raised to the level found in the sample. Samples affected were: cadmium in -28 and -35.

Zinc in sample -2 and cadmium in samples -21, -47, and -73 were J-coded. Although the analytes in question have been positively identified in the samples, the quantitations are an estimate (J-coded) due to recoveries of these analytes (zinc: 151% and cadmium: 67-333%) in the laboratory matrix spikes outside control limits (75-125%). The actual concentrations for cadmium and zinc may be lower and for cadmium may be higher than the reported values.

Cadmium in sample -2 and zinc in sample -23 were J-coded. Although the analytes in question have been positively identified in these samples, the quantitations are an estimate (J-coded) due to the serial dilution percent differences (Cd: 15.9% and Zn: 20%) being above the control limits(15%). The actual concentrations for cadmium may be lower and for zinc may be higher than the reported values.

Lead and zinc were above the control limits by (3% and 1.8%, respectively) in the performance evaluation (PE) sample -353PE associated with samples -23 through -35. No data were qualified based on the PE results.

Analysis/ Analyte	Units	1-__	2-__	3-__	4-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	37.0	0.63 J	48.2	37.7
Lead	mg/kg	225	24.6	369	152
Zinc	mg/kg	8910	97.1 J	11900	8680

Analysis/ Analyte	Units	5-__	6-__	7-__	8-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	41.5	38.6	79.3	67.2
Lead	mg/kg	338	398	906	266
Zinc	mg/kg	9860	8190	16800	15200

Analysis/ Analyte	Units	9-__	10-__	11-__	12-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	24.1	113	29.2	27.0
Lead	mg/kg	3260	837	417	193
Zinc	mg/kg	7170	22000	4500	5780

Analysis/ Analyte	Units	12-FD	14-__	15-__	16-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	37.0	1.7	40.3	35.3
Lead	mg/kg	257	61.5	270	510
Zinc	mg/kg	7200	393	9610	7520

Analysis/ Analyte	Units	16-FD	18-__	19-__	20-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	30.1	11.2	16.4	7.4
Lead	mg/kg	361	556	461	149
Zinc	mg/kg	6430	1820	2330	1210

Analysis/ Analyte	Units	21-__	22-__	23-__	23-FD
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	8.9 J	16.8	15.6	12.4
Lead	mg/kg	265	528	240	198
Zinc	mg/kg	1600	2530	1290 J	1140

Analysis/ Analyte	Units	24-__	25-__	26-__	27-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	4.3	86.3	39.2	15.6
Lead	mg/kg	53.8	288	78.0	58.1
Zinc	mg/kg	946	19300	6730	1370

Analysis/ Analyte	Units	28-__	29-__	30-__	30-FD
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	1.5 U	50.9	12.9	13.7
Lead	mg/kg	74.8	1050	916	981
Zinc	mg/kg	123	10300	3470	3770

Analysis/ Analyte	Units	31-__	32-__	33-__	34-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	11.5	0.43 U	24.5	43.9
Lead	mg/kg	468	7.3	364	123
Zinc	mg/kg	2260	13.9	4830	7680

Analysis/ Analyte	Units	35-__	36-__	37-__	38-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	0.53 U	42.6	43.4	52.8
Lead	mg/kg	22.7	490	266	475
Zinc	mg/kg	67.5	9870	9920	13300

Analysis/ Analyte	Units	39-__	40-__	41-__	42-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	84.6	24.3	17.0	36.5
Lead	mg/kg	1940	322	76.6	609
Zinc	mg/kg	16200	6080	2430	6640

Analysis/ Analyte	Units	43-__	44-__	45-__	46-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	2.1	37.9	49.2	33.4
Lead	mg/kg	86.0	386	1960	472
Zinc	mg/kg	383	8090	14100	8450

Analysis/ Analyte	Units	47-__	48-__	49-__	50-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	37.2 J	55.2	54.5	29.5
Lead	mg/kg	884	429	4260	392
Zinc	mg/kg	8100	10500	12100	5770

Analysis/ Analyte	Units	51-__	52-__	53-__	54-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	69.8	48.6	100	10.2
Lead	mg/kg	466	403	2310	1500
Zinc	mg/kg	12500	10700	17700	2040

Analysis/ Analyte	Units	55-__	56-__	57-__	57-FD
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	62.6	33.9	55.4	33.8
Lead	mg/kg	380	476	3600	3340
Zinc	mg/kg	11400	6100	13700	10500

Analysis/ Analyte	Units	59-__	59-FD	61-__	61-FD
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	60.0	54.9	38.4	42.6
Lead	mg/kg	727	880	887	737
Zinc	mg/kg	11600	10100	7940	7280

Analysis/ Analyte	Units	63-__	63-FD	65-__	66-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	105	55.5	107	4.4
Lead	mg/kg	1150	1320	1260	329
Zinc	mg/kg	18400	12300	21700	722

Analysis/ Analyte	Units	66-FD	68-__	69-__	70-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	3.1	59.1	45.9	41.7
Lead	mg/kg	178	1390	1640	3750
Zinc	mg/kg	545	11400	8470	4100

Analysis/ Analyte	Units	71-__	72-__	73-__	74-__
1 Metals in Solids by ICP-AES					
Cadmium	mg/kg	9.7	45.1	38.8 J	46.5
Lead	mg/kg	300	457	827	820
Zinc	mg/kg	3600	12000	12600	9420

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Region VII
300 Minnesota Avenue
Kansas City, KS 66101

Date: __/__/____

Subject: Data Disposition/Sample Release for ASR #: 6105

Project ID: EC073708

Project Description: Cherokee County - Railroads

From: Elizabeth Coffey
SUPR/SPEB

To: Alisha Claycamp
ENSV/CARB

I have received and reviewed the Transmittal of Sample Analysis Results for the above-referenced Analytical Services Request(ASR) and have indicated my findings below by checking one of the boxes for Data Disposition.

I understand all samples will be disposed upon receipt of this form, unless samples are requested to be held. If I do not return this form all samples will be disposed of on ___________________.

☐ "RELEASED" - Read-only to all Region 7 employees and contractors that have R7LIMS "Customer" account. All Samples may be disposed of upon receipt of this form if not requested to be held.

☐ "Project Manager Accessible" - Available on the LAN in R7LIMS for my use only. All Samples may be disposed of upon receipt of this form if not requested to be held.

☐ "Archived" - THIS DATA IS OF A SENSITIVE NATURE. Any future reports must be requested through the laboratory. All samples may be disposed of upon receipt of the form if not requested to be held.

☐ Hold Samples - I have determined that the samples need to be held until ______________, after which time they will be disposed of in accordance with applicable regulations.
The reason for the hold is:

☐ Samples are associated with a legal proceeding.

☐ Question/Concern with data - possible reanalysis requested.

☐ Other:____

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01/09/2014

Results of Sample Analysis

Sample: 6105-1
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-1. This sample was collected on 05/08/2013 at the location described as: CCR-SS-9C (24-30). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-1 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	37.0	Milligrams per Kilogram
Lead	225	Milligrams per Kilogram
Zinc	8910	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-2
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-2. This sample was collected on 05/08/2013 at the location described as: CCR-SS-9B (42-48). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-2 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	Approximately 0.63	Milligrams per Kilogram
Lead	24.6	Milligrams per Kilogram
Zinc	Approximately 97.1	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-3
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-3. This sample was collected on 05/08/2013 at the location described as: CCR-SO-9A (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-3 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	48.2	Milligrams per Kilogram
Lead	369	Milligrams per Kilogram
Zinc	11900	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-4
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-4. This sample was collected on 05/08/2013 at the location described as: CCR-SS-10C (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-4 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	37.7	Milligrams per Kilogram
Lead	152	Milligrams per Kilogram
Zinc	8680	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-5
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-5. This sample was collected on 05/08/2013 at the location described as: CCR-SS-10B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-5 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	41.5	Milligrams per Kilogram
Lead	338	Milligrams per Kilogram
Zinc	9860	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-6
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-6. This sample was collected on 05/08/2013 at the location described as: CCR-SO-10A (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-6 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	38.6	Milligrams per Kilogram
Lead	398	Milligrams per Kilogram
Zinc	8190	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-7
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-7. This sample was collected on 05/08/2013 at the location described as: CCR-SS-8B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-7 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	79.3	Milligrams per Kilogram
Lead	906	Milligrams per Kilogram
Zinc	16800	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-8
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-8. This sample was collected on 05/08/2013 at the location described as: CCR-SS-8A (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-8 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	67.2	Milligrams per Kilogram
Lead	266	Milligrams per Kilogram
Zinc	15200	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-9
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-9. This sample was collected on 05/09/2013 at the location described as: CCR-SS-5BN (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-9 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	24.1	Milligrams per Kilogram
Lead	3260	Milligrams per Kilogram
Zinc	7170	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-10
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-10. This sample was collected on 05/09/2013 at the location described as: CCR-SS-5A (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-10 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	113	Milligrams per Kilogram
Lead	837	Milligrams per Kilogram
Zinc	22000	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-11
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-11. This sample was collected on 05/09/2013 at the location described as: CCR-SS-3A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-11 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	29.2	Milligrams per Kilogram
Lead	417	Milligrams per Kilogram
Zinc	4500	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-12
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-12. This sample was collected on 05/09/2013 at the location described as: CCR-SS-4A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-12 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	27.0	Milligrams per Kilogram
Lead	193	Milligrams per Kilogram
Zinc	5780	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-12-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-12-FD. This sample was collected on 05/09/2013 at the location described as: CCR-SS-4A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-12-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	37.0	Milligrams per Kilogram
Lead	257	Milligrams per Kilogram
Zinc	7200	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-14
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-14. This sample was collected on 05/09/2013 at the location described as: CCR-SS-3B (30-36). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-14 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	1.7	Milligrams per Kilogram
Lead	61.5	Milligrams per Kilogram
Zinc	393	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-15
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-15. This sample was collected on 05/09/2013 at the location described as: CCR-SS-7B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-15 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	40.3	Milligrams per Kilogram
Lead	270	Milligrams per Kilogram
Zinc	9610	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-16
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-16. This sample was collected on 05/09/2013 at the location described as: CCR-SS-7A (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-16 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	35.3	Milligrams per Kilogram
Lead	510	Milligrams per Kilogram
Zinc	7520	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-16-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-16-FD. This sample was collected on 05/09/2013 at the location described as: CCR-SS-7A (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-16-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	30.1	Milligrams per Kilogram
Lead	361	Milligrams per Kilogram
Zinc	6430	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-18
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-18. This sample was collected on 05/10/2013 at the location described as: CCR-SS-15B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-18 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	11.2	Milligrams per Kilogram
Lead	556	Milligrams per Kilogram
Zinc	1820	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-19
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-19. This sample was collected on 05/10/2013 at the location described as: CCR-SO-15A (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-19 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	16.4	Milligrams per Kilogram
Lead	461	Milligrams per Kilogram
Zinc	2330	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-20
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-20. This sample was collected on 05/10/2013 at the location described as: CCR-SS-13A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-20 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	7.4	Milligrams per Kilogram
Lead	149	Milligrams per Kilogram
Zinc	1210	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-21
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-21. This sample was collected on 05/10/2013 at the location described as: CCR-SO-16B (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-21 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	Approximately 8.9	Milligrams per Kilogram
Lead	265	Milligrams per Kilogram
Zinc	1600	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-22
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-22. This sample was collected on 05/10/2013 at the location described as: CCR-SO-16A (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-22 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	16.8	Milligrams per Kilogram
Lead	528	Milligrams per Kilogram
Zinc	2530	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-23
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-23. This sample was collected on 06/11/2013 at the location described as: CCR-SS-20A (36-42). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-23 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	15.6	Milligrams per Kilogram
Lead	240	Milligrams per Kilogram
Zinc	Approximately 1290	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-23-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-23-FD. This sample was collected on 06/11/2013 at the location described as: CCR-SS-20A (36-42). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-23-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	12.4	Milligrams per Kilogram
Lead	198	Milligrams per Kilogram
Zinc	1140	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-24
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-24. This sample was collected on 06/11/2013 at the location described as: CCR-SS-18A (24-30). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-24 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	4.3	Milligrams per Kilogram
Lead	53.8	Milligrams per Kilogram
Zinc	946	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-25
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-25. This sample was collected on 06/11/2013 at the location described as: CCR-SS-17C (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-25 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	86.3	Milligrams per Kilogram
Lead	288	Milligrams per Kilogram
Zinc	19300	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-26
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-26. This sample was collected on 06/11/2013 at the location described as: CCR-SS-17B (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-26 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	39.2	Milligrams per Kilogram
Lead	78.0	Milligrams per Kilogram
Zinc	6730	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-27
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-27. This sample was collected on 06/11/2013 at the location described as: CCR-SS-20B (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-27 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	15.6	Milligrams per Kilogram
Lead	58.1	Milligrams per Kilogram
Zinc	1370	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-28
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-28. This sample was collected on 06/11/2013 at the location described as: CCR-SS-19A (36-42). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-28 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	Less Than 1.5	Milligrams per Kilogram
Lead	74.8	Milligrams per Kilogram
Zinc	123	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-29
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-29. This sample was collected on 06/11/2013 at the location described as: CCR-SS-17A (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-29 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	50.9	Milligrams per Kilogram
Lead	1050	Milligrams per Kilogram
Zinc	10300	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-30
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-30. This sample was collected on 06/12/2013 at the location described as: CCR-SS-21C (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-30 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	12.9	Milligrams per Kilogram
Lead	916	Milligrams per Kilogram
Zinc	3470	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-30-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-30-FD. This sample was collected on 06/12/2013 at the location described as: CCR-SS-21C (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-30-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	13.7	Milligrams per Kilogram
Lead	981	Milligrams per Kilogram
Zinc	3770	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-31
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-31. This sample was collected on 06/12/2013 at the location described as: CCR-SS-21B (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-31 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	11.5	Milligrams per Kilogram
Lead	468	Milligrams per Kilogram
Zinc	2260	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-32
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-32. This sample was collected on 06/12/2013 at the location described as: CCR-SS-22A (30-36). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-32 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	Less Than 0.43	Milligrams per Kilogram
Lead	7.3	Milligrams per Kilogram
Zinc	13.9	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-33
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-33. This sample was collected on 06/12/2013 at the location described as: CCR-SS-21A (24-30). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-33 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	24.5	Milligrams per Kilogram
Lead	364	Milligrams per Kilogram
Zinc	4830	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-34
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-34. This sample was collected on 06/12/2013 at the location described as: CCR-SS-23B (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-34 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	43.9	Milligrams per Kilogram
Lead	123	Milligrams per Kilogram
Zinc	7680	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-35
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-35. This sample was collected on 06/12/2013 at the location described as: CCR-SS-22A (36-42). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-35 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	Less Than 0.53	Milligrams per Kilogram
Lead	22.7	Milligrams per Kilogram
Zinc	67.5	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-36
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-36. This sample was collected on 12/02/2013 at the location described as: CCR-SS-1A (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-36 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	42.6	Milligrams per Kilogram
Lead	490	Milligrams per Kilogram
Zinc	9870	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-37
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-37. This sample was collected on 12/02/2013 at the location described as: CCR-SS-1B (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-37 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	43.4	Milligrams per Kilogram
Lead	266	Milligrams per Kilogram
Zinc	9920	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-38
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-38. This sample was collected on 12/02/2013 at the location described as: CCR-SS-1C (24-30). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-38 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	52.8	Milligrams per Kilogram
Lead	475	Milligrams per Kilogram
Zinc	13300	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-39
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-39. This sample was collected on 12/02/2013 at the location described as: CCR-SS-2A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-39 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	84.6	Milligrams per Kilogram
Lead	1940	Milligrams per Kilogram
Zinc	16200	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-40
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-40. This sample was collected on 12/02/2013 at the location described as: CCR-SS-6A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-40 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	24.3	Milligrams per Kilogram
Lead	322	Milligrams per Kilogram
Zinc	6080	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-41
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-41. This sample was collected on 12/02/2013 at the location described as: CCR-SS-6B (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-41 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	17.0	Milligrams per Kilogram
Lead	76.6	Milligrams per Kilogram
Zinc	2430	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-42
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-42. This sample was collected on 12/03/2013 at the location described as: CCR-SS-24B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-42 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	36.5	Milligrams per Kilogram
Lead	609	Milligrams per Kilogram
Zinc	6640	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-43
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-43. This sample was collected on 12/03/2013 at the location described as: CCR-SS-24A (24-30). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-43 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	2.1	Milligrams per Kilogram
Lead	86.0	Milligrams per Kilogram
Zinc	383	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-44
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-44. This sample was collected on 12/03/2013 at the location described as: CCR-SS-25B (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-44 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	37.9	Milligrams per Kilogram
Lead	386	Milligrams per Kilogram
Zinc	8090	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-45
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-45. This sample was collected on 12/03/2013 at the location described as: CCR-SS-25A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-45 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	49.2	Milligrams per Kilogram
Lead	1960	Milligrams per Kilogram
Zinc	14100	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-46
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-46. This sample was collected on 12/03/2013 at the location described as: CCR-SS-26B (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-46 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	33.4	Milligrams per Kilogram
Lead	472	Milligrams per Kilogram
Zinc	8450	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-47
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-47. This sample was collected on 12/03/2013 at the location described as: CCR-SS-26A (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-47 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	Approximately 37.2	Milligrams per Kilogram
Lead	884	Milligrams per Kilogram
Zinc	8100	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-48
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-48. This sample was collected on 12/03/2013 at the location described as: CCR-SS-27B (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-48 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	55.2	Milligrams per Kilogram
Lead	429	Milligrams per Kilogram
Zinc	10500	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-49
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-49. This sample was collected on 12/03/2013 at the location described as: CCR-SS-27A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-49 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	54.5	Milligrams per Kilogram
Lead	4260	Milligrams per Kilogram
Zinc	12100	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-50
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-50. This sample was collected on 12/03/2013 at the location described as: CCR-SS-28B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-50 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	29.5	Milligrams per Kilogram
Lead	392	Milligrams per Kilogram
Zinc	5770	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-51
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-51. This sample was collected on 12/03/2013 at the location described as: CCR-SS-28A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-51 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	69.8	Milligrams per Kilogram
Lead	466	Milligrams per Kilogram
Zinc	12500	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-52
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-52. This sample was collected on 12/03/2013 at the location described as: CCR-SS-29B (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-52 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	48.6	Milligrams per Kilogram
Lead	403	Milligrams per Kilogram
Zinc	10700	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-53
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-53. This sample was collected on 12/04/2013 at the location described as: CCR-SS-30A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-53 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	100	Milligrams per Kilogram
Lead	2310	Milligrams per Kilogram
Zinc	17700	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-54
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-54. This sample was collected on 12/04/2013 at the location described as: CCR-SS-30B (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-54 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	10.2	Milligrams per Kilogram
Lead	1500	Milligrams per Kilogram
Zinc	2040	Milligrams per Kilogram

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Results of Sample Analysis

Sample: 6105-55
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-55. This sample was collected on 12/04/2013 at the location described as: CCR-SS-29A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-55 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	62.6	Milligrams per Kilogram
Lead	380	Milligrams per Kilogram
Zinc	11400	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-56
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-56. This sample was collected on 12/04/2013 at the location described as: CCR-SS-31B (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-56 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	33.9	Milligrams per Kilogram
Lead	476	Milligrams per Kilogram
Zinc	6100	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-57
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-57. This sample was collected on 12/04/2013 at the location described as: CCR-SS-31A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-57 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	55.4	Milligrams per Kilogram
Lead	3600	Milligrams per Kilogram
Zinc	13700	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-57-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-57-FD. This sample was collected on 12/04/2013 at the location described as: CCR-SS-31A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-57-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	33.8	Milligrams per Kilogram
Lead	3340	Milligrams per Kilogram
Zinc	10500	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-59
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-59. This sample was collected on 12/04/2013 at the location described as: CCR-SS-33A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-59 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	60.0	Milligrams per Kilogram
Lead	727	Milligrams per Kilogram
Zinc	11600	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-59-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-59-FD. This sample was collected on 12/04/2013 at the location described as: CCR-SS-33A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-59-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	54.9	Milligrams per Kilogram
Lead	880	Milligrams per Kilogram
Zinc	10100	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-61
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-61. This sample was collected on 12/04/2013 at the location described as: CCR-SS-33B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-61 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	38.4	Milligrams per Kilogram
Lead	887	Milligrams per Kilogram
Zinc	7940	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-61-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-61-FD. This sample was collected on 12/04/2013 at the location described as: CCR-SS-33B (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-61-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	42.6	Milligrams per Kilogram
Lead	737	Milligrams per Kilogram
Zinc	7280	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-63
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-63. This sample was collected on 12/04/2013 at the location described as: CCR-SS-32A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-63 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	105	Milligrams per Kilogram
Lead	1150	Milligrams per Kilogram
Zinc	18400	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-63-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-63-FD. This sample was collected on 12/04/2013 at the location described as: CCR-SS-32A (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-63-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	55.5	Milligrams per Kilogram
Lead	1320	Milligrams per Kilogram
Zinc	12300	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-65
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-65. This sample was collected on 12/04/2013 at the location described as: CCR-SS-32B (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-65 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	107	Milligrams per Kilogram
Lead	1260	Milligrams per Kilogram
Zinc	21700	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-66
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-66. This sample was collected on 12/04/2013 at the location described as: CCR-SS-13E (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-66 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	4.4	Milligrams per Kilogram
Lead	329	Milligrams per Kilogram
Zinc	722	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-66-FD
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-66-FD. This sample was collected on 12/04/2013 at the location described as: CCR-SS-13E (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-66-FD for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	3.1	Milligrams per Kilogram
Lead	178	Milligrams per Kilogram
Zinc	545	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-68
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-68. This sample was collected on 12/04/2013 at the location described as: CCR-SS-13C (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-68 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	59.1	Milligrams per Kilogram
Lead	1390	Milligrams per Kilogram
Zinc	11400	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-69
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-69. This sample was collected on 12/05/2013 at the location described as: CCR-SS-13B (18-24). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-69 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	45.9	Milligrams per Kilogram
Lead	1640	Milligrams per Kilogram
Zinc	8470	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-70
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-70. This sample was collected on 12/05/2013 at the location described as: CCR-SS-13D (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-70 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	41.7	Milligrams per Kilogram
Lead	3750	Milligrams per Kilogram
Zinc	4100	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-71
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-71. This sample was collected on 12/05/2013 at the location described as: CCR-SS-12A (12-18). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-71 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	9.7	Milligrams per Kilogram
Lead	300	Milligrams per Kilogram
Zinc	3600	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-72
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-72. This sample was collected on 12/05/2013 at the location described as: CCR-SS-12B (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-72 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	45.1	Milligrams per Kilogram
Lead	457	Milligrams per Kilogram
Zinc	12000	Milligrams per Kilogram

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01/09/2014

Results of Sample Analysis

Sample: 6105-73
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-73. This sample was collected on 12/05/2013 at the location described as: CCR-SS-11A (0-6). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-73 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	Approximately 38.8	Milligrams per Kilogram
Lead	827	Milligrams per Kilogram
Zinc	12600	Milligrams per Kilogram

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Lenexa, KS 66219

01/09/2014

Results of Sample Analysis

Sample: 6105-74
Project ID: EC073708

These are the results from the analysis of solid sample number 6105-74. This sample was collected on 12/05/2013 at the location described as: CCR-SS-13A (6-12). If you have any questions about these results, contact Elizabeth Coffey at the above address or by calling 913-551-7939. Correspondence should refer to sample number 6105-74 for project: EC073708 - Cherokee County - Railroads.

Analysis/Analyte	Amount Found	Units
Metals in Soil by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)		
Cadmium	46.5	Milligrams per Kilogram
Lead	820	Milligrams per Kilogram
Zinc	9420	Milligrams per Kilogram

APPENDIX G

FIELD DUPLICATE RELATIVE PERCENT DIFFERENCE CALCULATIONS

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Appendix G
Relative Percent Difference Calculations
Laboratory Data
Cherokee County Superfund Site OU8

	CCR-SS-4A (18-24)					CCR-SS-7A (12-18)					CCR-SS-20A (36-42)					CCR-SS-21C (6-12)					CCR-SS-31A (18-24)				
Contaminant	**6105-12**		**6105-12-FD**		**RPD**	**6105-16**		**6105-16-FD**		**RPD**	**6105-23**		**6105-23-FD**		**RPD**	**6105-30**		**6105-30-FD**		**RPD**	**6105-57**		**6105-57-FD**		**RPD**
Cadmium	27.0		37.0		**31.3**	35.3		30.1		-15.9	15.6		12.4		-22.9	12.9		13.7		6.0	55.4		33.8		**-48.4**
Lead	193		257		**28.4**	510		361		**-34.2**	240		198		-19.2	916		981		6.9	3600		3340		-7.5
Zinc	5780		7200		21.9	7520		6430		-15.6	1290	J	1140		-12.3	3470		3770		8.3	13700		10500		**-26.4**

	CCR-SS-33A (6-12)					CCR-SS-33B (6-12)					CCR-SS-32A (18-24)					CCR-SS-13E (18-24)				
Contaminant	**6105-59**		**6105-59-FD**		**RPD**	**6105-61**		**6105-61-FD**		**RPD**	**6105-63**		**6105-63-FD**		**RPD**	**6105-66**		**6105-66-FD**		**RPD**
Cadmium	60.0		54.9		-8.9	38.4		42.6		10.4	105		55.5		**-61.7**	4.4		3.1		**-34.7**
Lead	727		880		19.0	887		737		-18.5	1150		1320		13.8	329		178		**-59.6**
Zinc	11600		10100		-13.8	7940		7280		-8.7	18400		12300		**-39.7**	722		545		**-27.9**

Notes:

FD = field duplicate

J = estimated value

RPD = relative percent difference

U = not detected

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APPENDIX H

DAMES AND MOORE 1993 BACKGROUND SOIL SAMPLE LOCATIONS

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Perched water samples collected from wells were labeled and transported following provisions in SOP-9 and were analyzed for the same constituents as ground-water samples. For QA/QC sample frequency, the perched ground-water samples count toward the overall ground-water sample totals. Overall, ground-water samples are collected at a frequency of five percent (one per 20) as specified in the SAP.

3.2 SOILS INVESTIGATION

Because subsite mill waste piles are believed to be fugitive dust sources, a soil sampling program was implemented to compare soil metal concentrations in areas away from mill wastes (baseline soils) to concentrations found in soils near the mill waste accumulations. Samples were also collected to characterize other major soil types of the subsites including 1) soils near mill waste piles and mill sites and 2) fallow, tilled, or planted agricultural soils and tame grass pasture soils. All soil samples were tested for metals (SAP, Table 9); results from the soil characterization efforts will be used in general site characterization and in the risk assessment.

3.2.1 Baseline Soil Sampling

The identification of soils exhibiting elevated metals concentrations required comparison to background or baseline soil metal values. Because the potential impacts from anthropogenic sources (mill waste dust, auto emissions, dust and fertilizer from fields, etc.) on near-surface soils was unknown, it was determined that samples from a deeper soil horizon would provide the best available baseline data base. The data base was developed by collecting eight samples from the B soil Horizon. The B Horizon typically occurs some 14 to 24 inches below the ground surface.

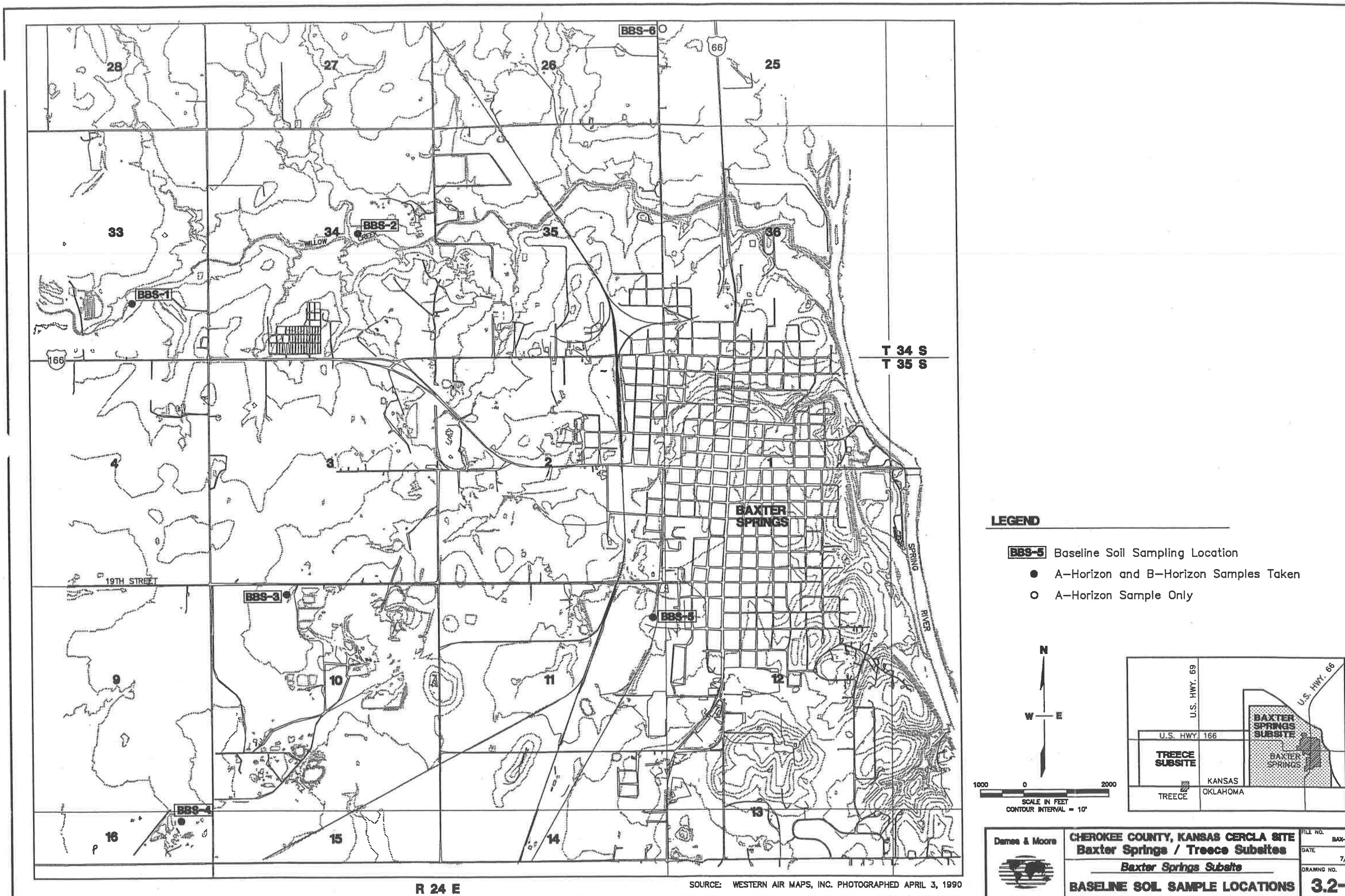
3.2.1.1 Baseline Sample Locations

Five locations in the Baxter Springs and three locations in the Treece subsite were chosen for baseline soil sampling. Sampling sites chosen were those which, upon excavation, did not exhibit visible inclusion of chat from chat-covered roads or mill wastes from neighboring deposits. Although croplands cover much of the project area, they were not considered for baseline sampling due to potential anthropogenic effects.

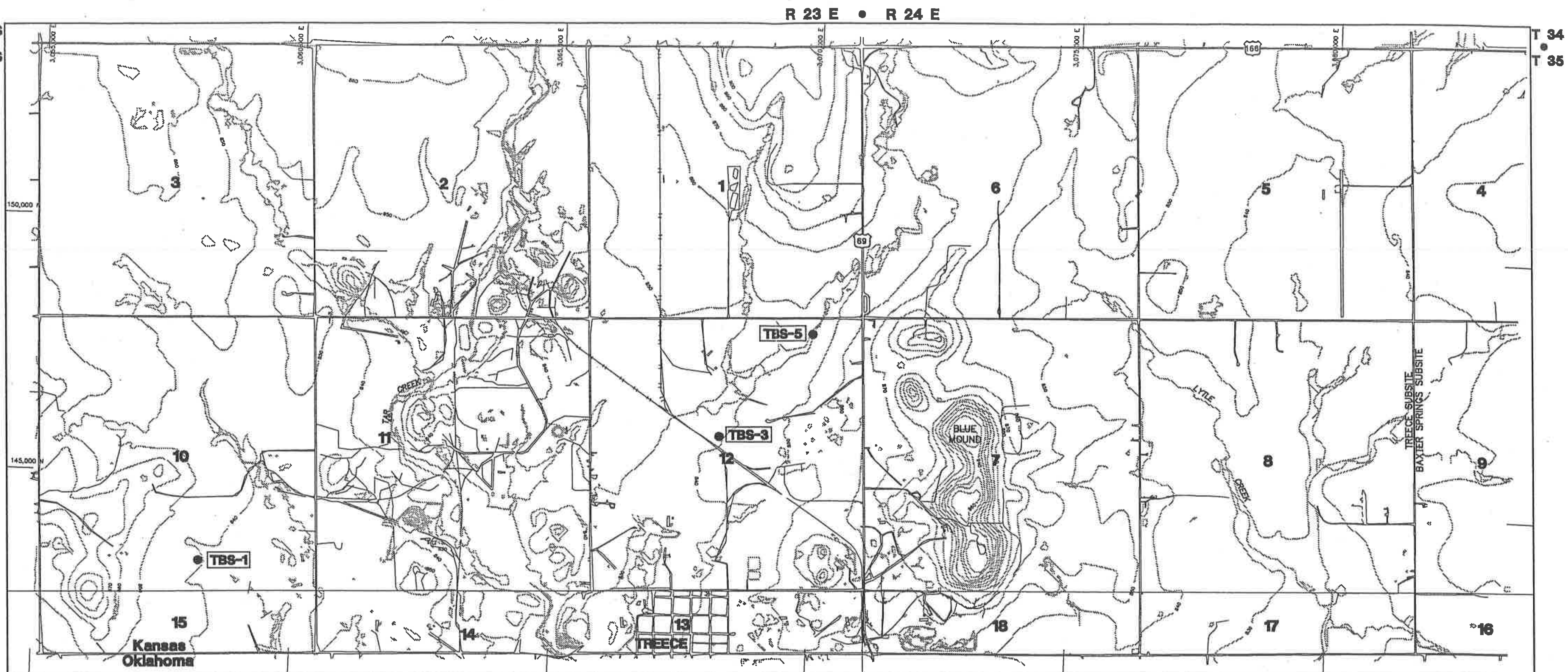
The Baxter Springs subsite sampling locations are shown on Figure 3.2-1 and are designated as a Baxter Baseline Soil, BBS-#. Sample sites BBS-1 and BBS-2 are located within the Helper silt loam soil series. The BBS-1 sampling location is adjacent to Willow Creek in an oak-maple-elm mixed forest. BBS-2 is located in a grassland vegetation community, on a floodplain approximately 200 feet north of the Willow Creek channel.

BBS-3, BBS-4 and BBS-5 all occur within the Taloka silt loam soil series. The BBS-3 sample was taken from a pasture west of the Ballard quarry. Both the BBS-4 and BBS-5 samples were taken in forested areas (oak-maple-elm mixed community) near mill waste accumulations.

The three Treece baseline soil sampling locations are shown on Figure 3.2-2 and are designated as a Treece Baseline Soil, TBS-#. The TBS-1 location is in a Taloka silt loam soil series in a grass pasture west of Treece. Both TBS-3 and TBS-5 are located in the Hepler silt loam soil series in forested areas (oak-maple-elm). Two other stations, TBS-2 and TBS-4 (not shown on Figure 3.2-2) were originally included in the baseline soil sampling program. Because of their proximity to mill waste accumulations however, they have been categorized as "near-pile" sampling locations, and will be discussed later.



BBS-6
BBS-2
BBS-1
BBS-3
BBS-5
BBS-4
28
27
26
25
33
34
35
36
4
3
2
1
9
10
11
12
16
15
14
13
WILLOW CREEK
166
66
19TH STREET
BAXTER SPRINGS
SPRING RIVER
T 34 S
T 35 S
R 24 E
SOURCE: WESTERN AIR MAPS, INC. PHOTOGRAPHED APRIL 3, 1990
LEGEND
BBS-5 Baseline Soil Sampling Location
A–Horizon and B–Horizon Samples Taken
A–Horizon Sample Only
N
W
E
1000
0
2000
SCALE IN FEET
CONTOUR INTERVAL = 10'
U.S. HWY. 69
U.S. HWY. 66
U.S. HWY. 166
BAXTER SPRINGS SUBSITE
BAXTER SPRINGS
TREECE SUBSITE
KANSAS
OKLAHOMA
TREECE
Dames & Moore
CHEROKEE COUNTY, KANSAS CERCLA SITE
Baxter Springs / Treece Subsites
Baxter Springs Subsite
BASELINE SOIL SAMPLE LOCATIONS
FILE NO. BAX-08
DATE 7/92
DRAWING NO. 3.2-1

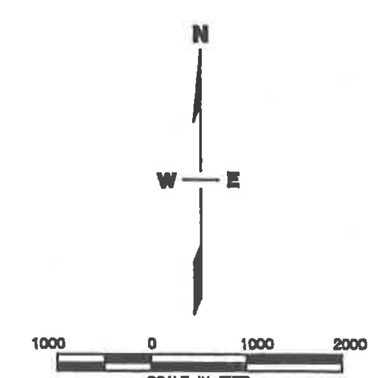


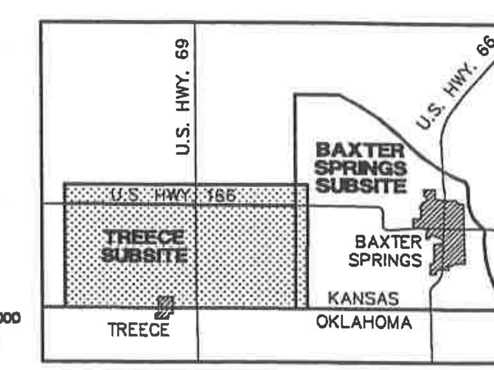
SOURCE: WESTERN AIR MAPS, INC., PHOTOGRAPHED APRIL 3, 1990

LEGEND

TBS-1 Baseline Soil Sampling Location

● A–Horizon and B–Horizon Samples Taken





Dames & Moore

CHEROKEE COUNTY, KANSAS CERCLA SITE
Baxter Springs / Treece Subsites

Treece Subsite

BASELINE SOIL SAMPLE LOCATIONS

FILE NO. TRC-09
DATE 7/92
DRAWING NO. **3.2-2**

APPENDIX I

FIELD SCREENING DATA SUMMARY

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Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	Zinc	Cadmium
Residential Soil RSL		*400*	*2,300*	*7.1*
1A	0-6	577	7,750	29
	6-12	637	9,477	36
	12-18	535	22,067	51
	18-24	187	14,733	50
	24-30	134	1,700	14
	30-36	14	2,093	20
	36-42	27	346	<12.4
	42-48	35	182	<12.6
1B	0-6	327	7,453	18
	6-12	681	8,138	28
	12-18	532	10,057	32
	18-24	403	9,936	29
	24-30	102	6,426	22
	30-36	<11.1	565	<13.1
	36-42	<9.2	133	<12.2
	42-48	19	316	<13.0
1B-E	0-6	125	3,433	16
	6-12	69	888	<11.8
1B-W	0-6	76	772	<12.8
	6-12	90	1080	<13.0
1C	0-6	108	3,583	17
	6-12	373	12,300	38
	12-18	203	16,600	29
	18-24	126	19,433	36
	24-30	242	13,111	36
	30-36	<11.8	511	<13.7
	36-42	19	315	<14.5
	42-48	14	1,773	17
2A	0-6	1,339	9,788	47
	6-12	2,077	11,833	74
	12-18	727	12,179	37
	18-24	690	18,433	62
	24-30	<9.8	461	<15.7
	30-36	31	563	<13.1
	36-42	208	1,799	<15.1
	42-48	<13.2	60	<15.2
3A	0-6	665	3,084	25
	6-12	292	4,646	25
	12-18	343	4,295	17
	18-24	89	2,518	<14.1
	24-30	29	661	<14.6
	30-36	21	1,133	<13.9
	36-42	32	280	<13.8
	42-48	59	216	<13.4
3B	0-6	1,724	9,616	47
	6-12	656	7,684	27
	12-18	27	231	<13.5
	18-24	19	2,321	74
	24-30	19	62	<14.1
	30-36	71	453	<13.9
	36-42	12	20	<12.8
	42-48	15	32	<14.5
3B-N	0-6	1,354	3,630	35
	6-12	649	2,257	<15.1
	12-18	2,161	5,157	27
3B-N2	0-6	2,014	7,148	51
4A	0-6	700	6,412	21
	6-12	432	7,402	21
	12-18	497	8,510	26
	18-24	226	6,997	22
	24-30	284	7,883	34
	30-36	164	8,239	30
5A	0-6	1,149	8,038	38
	6-12	786	7,700	30
	12-18	838	10,133	56
	18-24	525	6,041	30
	24-30	474	5,660	34
	30-36	170	1,576	19
	36-42	457	3,246	<14.9
	42-48	7	180	<12.9
5B	0-6	1,360	4,891	28
	6-12	1,044	7,875	15
	12-18	800	14,214	46
	18-24	568	18,433	33
	24-30	981	9,054	21
	30-36	871	6,070	30
5B-N	0-6	409	5,107	<11.8
	6-12	2,009	4,748	<15
	12-18	311	3,210	14
5B-S	0-6	572	7,946	66

Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	Zinc	Cadmium
Residential Soil RSL		*400*	*2,300*	*7.1*
6A	0-6	**134**	**1,573**	**17**
	6-12	**495**	**5,821**	**29**
	12-18	**453**	**6,504**	**32**
	18-24	**39**	**592**	< 13.7
	24-30	**19**	**295**	< 13.8
	30-36	**74**	**1,236**	< 13.0
	36-42	**94**	**2,855**	**49**
	42-48	**50**	**507**	< 14.1
6B	0-6	**112**	**1,241**	< 12.6
	6-12	**632**	**11,168**	**71**
	12-18	**409**	**9,805**	**41**
	18-24	**657**	**8,898**	**32**
	24-30	**13**	**463**	< 14.7
	30-36	**59**	**1,249**	< 12.8
	36-42	**21**	**181**	< 14.2
	42-48	**12**	**90**	< 12.0
7A	0-6	**367**	**12,300**	**38**
	6-12	**366**	**11,583**	**28**
	12-18	**365**	**5,207**	**18**
	18-24	**238**	**6,646**	**18**
	24-30	**325**	**4,547**	**33**
	30-36	**320**	**4,581**	**23**
	36-42	**178**	**2,492**	**18**
	42-48	**43**	**454**	< 13.9
7B	0-6	**310**	**7,055**	**23**
	6-12	**235**	**7,585**	**28**
	12-18	**547**	**13,375**	**58**
	18-24	**258**	**6,004**	**55**
	24-30	**317**	**7,837**	**22**
	30-36	**252**	**8,838**	**26**
	36-42	**252**	**5,948**	**23**
	42-48	**445**	**7,720**	**33**
8A	0-6	**322**	**8,220**	**32**
	6-12	**302**	**16,833**	**47**
	12-18	**236**	**14,900**	**29**
	18-24	**187**	**10,202**	**23**
	24-30	**61**	**6,204**	**28**
	30-36	**17**	**1,297**	**19**
	36-42	< 10.3	**117**	< 13
	42-48	**67**	**5,347**	**37**
8A-E	0-6	**39**	**356**	< 15.9
	6-12	**51**	**420**	< 12.7
8A-W	0-6	**60**	**655**	< 12.4
	6-12	< 9.1	**132**	< 12.8
8B	0-6	**269**	**4,313**	**25**
	6-12	**330**	**20,967**	**63**
	12-18	**294**	**9,958**	**42**
	18-24	**193**	**18,767**	**45**
	24-30	**14**	**466**	< 14.2
	30-36	**19**	**2,010**	**37**
	36-42	**28**	**1,081**	< 14.5
	42-48	**18**	**577**	< 13.9
9A	0-6	**364**	**8,751**	**25**
	6-12	**212**	**15,018**	**43**
	12-18	**125**	**7,536**	**29**
	18-24	**44**	**2,292**	**32**
	24-30	**31**	**376**	< 18.9
	30-36	**44**	**623**	< 17.3
	36-42	**15**	**29**	< 13.4
	42-48	< 11.1	**25**	< 13.2
9B	0-6	**2,271**	**5,884**	**14**
	6-12	**676**	**11,762**	**21**
	12-18	**305**	**13,709**	**23**
	18-24	**149**	**6,984**	**17**
	24-30	**368**	**8,760**	**22**
	30-36	**192**	**6,267**	< 15.5
	36-42	**58**	**1,104**	**40**
	42-48	**100**	**36**	< 14.6
9B-W	0-6	**93**	**2,579**	**18**
	6-12	**159**	**1,816**	**20**
9B-E	12-18	**272**	**753**	< 13.7
9C	0-6	**483**	**16,433**	**41**
	6-12	**374**	**13,833**	**37**
	12-18	**363**	**20,297**	**40**
	18-24	**195**	**6,787**	**26**
	24-30	**252**	**8,356**	**34**
	30-36	**150**	**5,466**	**25**
	36-42	**45**	**1,674**	< 13.3
	42-48	**24**	**220**	< 14.6

Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	Zinc	Cadmium
Residential Soil RSL		*400*	*2,300*	*7.1*
10A	0-6	**640**	**10,786**	**43**
	6-12	**606**	**16,933**	**54**
	12-18	**38**	**1,441**	<14.9
	18-24	**55**	**1,738**	<14.8
	24-30	<11.0	**62**	<14.8
	30-36	**15**	**123**	<13.3
	36-42	**19**	**58**	<15
	42-48	**20**	**225**	<13.9
10A-N	0-6	**131**	**1,148**	<13.7
	6-12	**261**	**890**	<13.6
10B	0-6	**473**	**12,367**	**63**
	6-12	**364**	**6,051**	**31**
	12-18	<10.2	**286**	<14.2
	18-24	**22**	**663**	<13.2
	24-30	**17**	**102**	<13.4
	30-36	**21**	**88**	<13.2
	36-42	**14**	**27**	<13.4
	42-48	<10.9	**59**	<14.1
10B-N	0-6	**13**	**94**	<13.0
	6-12	**16**	**71**	<16.7
10C	0-6	**85**	**6,176**	**27**
	6-12	**119**	**6,718**	**32**
	12-18	**22**	**273**	<13.1
	18-24	**19**	**1,431**	<15
	24-30	**26**	**318**	<12.8
	30-36	**14**	**220**	<13.5
	36-42	**27**	**114**	<14.9
	42-48	**16**	**20**	<15.2
11A	0-6	**573**	**15,967**	**25**
	6-12	**441**	**15,067**	**41**
	12-18	**739**	**12,167**	**39**
	18-24	**566**	**16,767**	**38**
	24-30	<9.5	**173**	<12.6
	30-36	<10.2	**29**	<13.0
	36-42	**63**	**289**	<13.8
	42-48	<10.8	**35**	<13.5
11A-N	0-6	**37**	**244**	<12.0
11A-S	0-6	**74**	**871**	<13.0
12A	0-6	**185**	**3,420**	<13.4
	6-12	**379**	**5,193**	<14.3
	12-18	**596**	**8,331**	**24**
	18-24	**219**	**2,198**	**20**
	24-30	**14**	**396**	<13.2
	30-36	<11.6	**170**	<13.3
	36-42	<9.5	**51**	<12.8
	42-48	<11.0	**70**	<13.0
12B	0-6	**478**	**11,610**	**37**
	6-12	**204**	**11,063**	**30**
	12-18	**200**	**7,840**	**27**
	18-24	**166**	**13,215**	**27**
	24-30	**12**	**23**	<13.2
	30-36	<10.3	**46**	<13.4
	36-42	<11.8	**64**	<13.6
	42-48	**16**	**32**	<16.0
12B-N	0-6	**65**	**545**	<12.4
12B-S	0-6	**52**	**577**	<10.9
13A	0-6	**672**	**12,900**	**43**
	6-12	**823**	**10,357**	**38**
	12-18	**619**	**10,433**	**41**
	18-24	**1,012**	**13,733**	**33**
	24-30	**1,123**	**15,700**	**35**
	30-36	**1,654**	**19,100**	**33**
	36-42	**1,029**	**7,429**	**22**
	42-48	**523**	**6,391**	**26**
13B	0-6	**856**	**3,834**	**21**
	6-12	**1,750**	**7,648**	**31**
	12-18	**1,488**	**2,912**	**23**
	18-24	**1,641**	**3,226**	**20**
	24-30	**651**	**2,525**	**27**
	30-36	**700**	**2,608**	**60**
	36-42	**244**	**1,315**	**20**
	42-48	**24**	**1,700**	<13.3
13B-N	0-6	**1,168**	**1,537**	<11.6
13B-S	0-6	**301**	**3,469**	<10.7
13C	0-6	**1,820**	**8,686**	**32**
	6-12	**1,282**	**5,743**	**33**
	12-18	**1,531**	**8,619**	**30**
	18-24	**1,518**	**7,398**	**41**
	24-30	**16,533**	**6,724**	**26**
	30-36	**1,492**	**10,169**	**38**
	36-42	<9.3	**452**	<13.7
	42-48	**96**	**2,831**	**30**

Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	Zinc	Cadmium
Residential Soil RSL		*400*	*2,300*	*7.1*
13D	0-6	**183**	**10,745**	**22**
	6-12	**2,255**	**5,275**	**36**
	12-18	**820**	**1,505**	< 13.4
	18-24	**782**	**447**	< 14.5
	24-30	**59**	**428**	< 14.4
	30-36	**150**	**579**	< 12.9
	36-42	**42**	**249**	< 13.0
	42-48	**43**	**235**	< 13.7
13E	0-6	**865**	**5,860**	**32**
	6-12	**902**	**6,183**	**28**
	12-18	**203**	**377**	< 13.7
	18-24	**426**	**531**	< 13.3
	24-30	< 10.0	**133**	< 12.3
	30-36	**25**	**135**	< 13.3
	36-42	**62**	**226**	< 12.0
	42-48	< 9.9	**197**	< 13.0
13E-S	0-6	**652**	**4,153**	< 13.5
13E-N	0-6	**1,255**	**4,540**	< 13.4
13-L	0-6	**238**	**4,504**	**19**
	6-12	**145**	**1,530**	< 12.9
	12-18	**41**	**532**	< 13.2
	18-24	< 11.2	**163**	< 13.8
	24-30	< 10	**37**	< 12.8
	30-36	**17**	**39**	< 13.4
	36-42	**12**	**52**	< 12.2
	42-48	< 9.4	**57**	< 13.2
14A	0-6	**104**	**5,763**	**24**
	6-12	**136**	**3,765**	**25**
	12-18	**169**	**2,760**	< 13.7
	18-24	**222**	**38**	< 13.2
	24-30	< 9.8	**64**	< 11.9
	30-36	**15**	**75**	< 12.2
14A-E	0-6	**80**	**539**	< 11.4
	6-12	**80**	**355**	< 11.0
14A-W	0-6	**96**	**940**	< 11.9
15A	0-6	**328**	**1,972**	< 13.6
	6-12	**244**	**1,249**	< 11.2
	12-18	**95**	**828**	< 11.6
	18-24	**62**	**536**	< 11.8
	24-30	**10**	**122**	< 12.7
	30-36	**16**	**255**	< 14.9
	36-42	< 10.1	**29**	< 12.8
	42-48	< 8.8	**18**	< 12.6
15B	0-6	**579**	**4,418**	< 12.3
	6-12	**443**	**2,597**	< 13.6
	12-18	**222**	**295**	< 12.9
	18-24	**247**	**310**	< 13.8
	24-30	**27**	**61**	< 12.0
	30-36	**11**	**45**	< 13.9
	36-42	**47**	**78**	< 14.8
	42-48	**14**	**45**	< 13.0
16A	0-6	**412**	**1,572**	< 12.3
	6-12	**194**	**757**	< 11.7
	12-18	**217**	**1,183**	< 13.1
	18-24	**19**	**162**	< 12.1
	24-30	**26**	**65**	< 15.2
	30-36	< 11.3	**27**	< 12.7
	36-42	**20**	**25**	< 12.7
	42-48	< 10.2	**18**	< 12.6
16A-E	0-6	**70**	**383**	< 12.5
16B	0-6	**158**	**530**	< 12.3
	6-12	**25**	**81**	< 12.7
	12-18	**30**	**81**	< 12.8
	18-24	**17**	**29**	< 11.9
	24-30	**13**	**18**	< 12
	30-36	**14**	**33**	< 13.6
	36-42	< 16.5	**38**	< 12.4
	42-48	< 10.2	**32**	< 12.9
17A	0-6	**570**	**6,795**	**44**
	6-12	**463**	**20,000**	**59**
	12-18	**987**	**15,200**	**60**
	18-24	**800**	**3,248**	**29**
	24-30	**127**	**1,640**	**17**
	30-36	< 12.4	**427**	< 12.5
	36-42	**18**	**218**	< 14.8
	42-48	< 14.0	**325**	< 13.9
17B	0-6	**281**	**2,829**	< 12.8
	6-12	**506**	**14,700**	**54**
	12-18	**422**	**30,050**	**72**
	18-24	**115**	**7,499**	**29**
	24-30	**56**	**329**	< 12.8
	30-36	< 11.1	**198**	< 11.7
	36-42	< 14.8	**32**	< 14.2
	42-48	< 13.1	**26**	< 12.5

Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	Zinc	Cadmium
Residential Soil RSL		*400*	*2,300*	*7.1*
17B-N	0-6	<14.1	**55**	**16**
17B-S	0-6	**676**	**6,267**	**28**
	6-12	**264**	**2,132**	**14**
17B-S2	0-6	**89**	**718**	<12.3
17C	0-6	**515**	**6,781**	**34**
	6-12	**516**	**9,644**	**39**
	12-18	**371**	**13,900**	**56**
	18-24	**329**	**13,867**	**57**
	24-30	**18**	**66**	<12.8
	30-36	**15**	**158**	<11.6
	36-42	<15.9	**83**	<12.9
	42-48	**22**	**126**	<13.8
18A	0-6	**421**	**13,075**	**52**
	6-12	**281**	**23,967**	**37**
	12-18	**63**	**425**	**16**
	18-24	<13.5	**63**	<13.5
	24-30	**18**	**647**	<12.0
	30-36	<11.4	**35**	<11.9
	36-42	<11.8	**59**	<13.2
	42-48	<12.7	**117**	<13.3
19A	0-6	**1,079**	**960**	**15**
	6-12	**246**	**1,120**	**20**
	12-18	**204**	**1,444**	**19**
	18-24	**860**	**994**	**17**
	24-30	**40**	**474**	<14
	30-36	**413**	**886**	<12.5
	36-42	**49**	**182**	<13.6
	42-48	**25**	**104**	<13.7
20A	0-6	<14.1	**260**	<13.1
	6-12	**14**	**267**	<12.1
	12-18	**25**	**329**	<13.8
	18-24	<13.1	**240**	<12.7
	24-30	<12.2	**200**	<11.8
	30-36	**44**	**286**	<13.8
	36-42	**114**	**960**	<12.5
	42-48	**19**	**515**	**15**
20B	0-6	**395**	**3,706**	**27**
	6-12	**138**	**1,939**	**24**
	12-18	**131**	**1,464**	**22**
	18-24	**94**	**813**	**14**
	24-30	**75**	**809**	<12.1
	30-36	**24**	**682**	<11.9
	36-42	**223**	**623**	**18**
	42-48	<13.4	**781**	**13**
21A	0-6	**461**	**2,690**	**21**
	6-12	**1,785**	**5,078**	**29**
	12-18	**889**	**9,934**	**41**
	18-24	**471**	**9,678**	**27**
	24-30	**262**	**3,367**	**39**
	30-36	**190**	**1,210**	**40**
	36-42	**16**	**86**	**15**
	42-48	**27**	**104**	**19**
21B	0-6	**534**	**5,298**	**24**
	6-12	**930**	**5,687**	**28**
	12-18	**600**	**7,905**	**25**
	18-24	**501**	**11,069**	**47**
	24-30	**76**	**852**	<12.9
	30-36	**86**	**439**	**18**
	36-42	**43**	**282**	<12.4
	42-48	**46**	**181**	<13.9
21C	0-6	**829**	**4,368**	**36**
	6-12	**1,151**	**3,367**	**22**
	12-18	**1,031**	**3,248**	**28**
	18-24	**390**	**7,836**	**34**
	24-30	**212**	**686**	**18**
	30-36	**583**	**3,510**	**21**
	36-42	**16**	**41**	**19**
	42-48	**18**	**59**	<11.5
22A	0-6	**716**	**4,007**	**27**
	6-12	**707**	**3,666**	**27**
	12-18	**655**	**6,454**	**32**
	18-24	**608**	**2,131**	**24**
	24-30	**173**	**1,095**	**26**
	30-36	**21**	**53**	<14.7
	36-42	**25**	**147**	<19.2
	42-48	**26**	**33**	**17**
23A	0-6	**309**	**8,039**	**23**
	6-12	**261**	**6,797**	**30**
	12-18	**76**	**2,669**	**16**
	18-24	**84**	**2,550**	**18**
	24-30	**21**	**368**	<11.7
	30-36	<11.4	**130**	<11.2
	36-42	**16**	**98**	<12.3
	42-48	<11.7	**208**	<11.6

Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	Zinc	Cadmium
Residential Soil RSL		*400*	*2,300*	*7.1*
23B	0-6	**317**	**6,314**	**25**
	6-12	**177**	**7,310**	**29**
	12-18	**295**	**13,392**	**39**
	18-24	**136**	**4,471**	**30**
	24-30	< 11.7	**191**	< 11.2
	30-36	< 11.7	**86**	< 11.5
	36-42	**95**	**397**	< 11.3
	42-48	< 13.0	**53**	< 15.7
24A	0-6	**388**	**5,711**	**26**
	6-12	**226**	**3,429**	< 14.9
	12-18	**270**	**3,443**	< 11.0
	18-24	**537**	**1,600**	< 13.6
	24-30	**98**	**143**	< 13.9
	30-36	**17**	**142**	< 13.4
	36-42	**26**	**155**	< 12.5
	42-48	**19**	**222**	< 13.6
24B	0-6	**310**	**3,286**	**17**
	6-12	**1,199**	**5,406**	**38**
	12-18	**558**	**4,977**	**18**
	18-24	**1,170**	**3,332**	< 13.0
	24-30	**530**	**11,707**	< 10.4
	30-36	**115**	**938**	**18**
	36-42	**51**	**1,821**	< 12.6
	42-48	**26**	**457**	< 11.9
25A	0-6	**420**	**5,463**	**21**
	6-12	**1,657**	**11,251**	**52**
	12-18	**785**	**7,921**	**25**
	18-24	**2,057**	**5,101**	**29**
	24-30	**832**	**8,416**	**33**
	30-36	**115**	**836**	< 12.9
	36-42	**22**	**110**	< 12.3
	42-48	**12**	**50**	< 13.3
25A-S	0-6	**129**	**1,080**	< 12.5
	6-12	**61**	**342**	< 12.8
25A-N	0-6	**239**	**2,085**	< 12.9
	6-12	**164**	**1,335**	< 13.1
25B	0-6	**397**	**5,988**	**32**
	6-12	**714**	**14,067**	**44**
	12-18	**729**	**14,267**	**38**
	18-24	**2,285**	**14,000**	**50**
	24-30	**2,957**	**16,340**	**31**
	30-36	**7,117**	**9,810**	**31**
	36-42	**1,902**	**3,385**	**35**
	42-48	**25**	**916**	< 13.2
26A	0-6	**701**	**6,876**	**48**
	6-12	**424**	**13,891**	**28**
	12-18	**364**	**5,315**	**20**
	18-24	**333**	**3,703**	< 13.9
	24-30	**7,855**	**7,010**	**31**
	30-36	**7,739**	**6,993**	**29**
	36-42	**192**	**393**	< 12.9
	42-48	**42**	**184**	< 12.8
26B	0-6	**313**	**6,238**	**20**
	6-12	**327**	**12,599**	**44**
	12-18	**238**	**10,995**	**20**
	18-24	**448**	**8,851**	**19**
	24-30	**708**	**1,868**	< 12.7
	30-36	**185**	**1,217**	**28**
	36-42	**110**	**744**	< 13.1
	42-48	< 10.4	**47**	< 13.2
26B-S	0-6	**85**	**480**	< 13.1
27A	0-6	**244**	**7,010**	**29**
	6-12	**1,428**	**4,993**	**46**
	12-18	**74**	**780**	< 13.4
	18-24	**439**	**1,244**	< 12.9
	24-30	**75**	**248**	< 13.0
	30-36	< 9.2	**237**	< 12.9
	36-42	< 9.3	**340**	< 12.7
	42-48	< 9.0	**258**	< 12.9
27B	0-6	**276**	**5,983**	**21**
	6-12	**549**	**3,120**	**20**
	12-18	**485**	**9,610**	**41**
	18-24	**239**	**10,847**	**42**
	24-30	**291**	**21,567**	**79**
	30-36	**555**	**11,867**	**69**
	36-42	< 9.5	**769**	< 12.3
	42-48	< 11.2	**192**	< 13.3
28A	0-6	**170**	**9,061**	**33**
	6-12	**611**	**17,433**	**52**
	12-18	**570**	**9,903**	**29**
	18-24	**784**	**5,214**	**24**
	24-30	**541**	**1,957**	< 14.5
	30-36	**699**	**3,336**	< 14.0
	36-42	< 11.6	**343**	< 13.4
	42-48	< 9.1	**170**	< 13.1
28A-S	0-6	**97**	**1,357**	< 13.5

Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	Zinc	Cadmium
Residential Soil RSL		*400*	*2,300*	*7.1*
28B	0-6	**391**	**6,136**	**31**
	6-12	**441**	**8,932**	**33**
	12-18	**600**	**7,870**	**44**
	18-24	**1,319**	**8,951**	**37**
	24-30	**859**	**3,073**	**24**
	30-36	**162**	**2,315**	< 14.1
	36-42	< 10.5	**35**	< 14.0
	42-48	**31**	**136**	< 13.3
28B-N	0-6	**48**	**703**	< 12.4
29A	0-6	**190**	**20,467**	**35**
	6-12	**197**	**17,100**	**37**
	12-18	**2,218**	**13,519**	**37**
	18-24	**422**	**9,494**	**40**
	24-30	**584**	**8,048**	**34**
	30-36	**86**	**1,940**	**18**
	36-42	**27**	**1,046**	< 13.0
	42-48	< 8.4	**199**	< 13.4
29B	0-6	**343**	**4,361**	**27**
	6-12	**321**	**7,693**	**27**
	12-18	**457**	**7,309**	**37**
	18-24	**324**	**7,448**	**32**
	24-30	**3,205**	**22,603**	**67**
	30-36	**2,289**	**8,755**	**48**
	36-42	**2,720**	**3,214**	**23**
	42-48	**2,013**	**3,040**	**24**
30A	0-6	**386**	**5,514**	**23**
	6-12	**653**	**11,509**	**23**
	12-18	**1,759**	**3,903**	**20**
	18-24	**1,706**	**7,926**	**29**
	24-30	**54**	**417**	< 13.4
	30-36	**887**	**3,928**	**30**
	36-42	**51**	**126**	< 14.8
	42-48	**237**	**1,636**	< 13.9
30B	0-6	**727**	**7,211**	**37**
	6-12	**1,054**	**5,191**	**23**
	12-18	**1,582**	**3,707**	**23**
	18-24	**3,490**	**1,821**	< 14.3
	24-30	**32**	**204**	< 12.9
	30-36	**425**	**2,688**	< 13.4
	36-42	**68**	**30**	< 13.5
	42-48	**18**	**55**	< 13.6
31A	0-6	**446**	**6,454**	**27**
	6-12	**463**	**6,775**	**30**
	12-18	**507**	**7,740**	**33**
	18-24	**1,355**	**5,157**	**43**
	24-30	**905**	**4,972**	**39**
	30-36	**1,598**	**2,386**	**38**
	36-42	**1,266**	**3,770**	**3,264**
	42-48	< 10.9	**41**	< 13.8
31A-N	0-6	**44**	**376**	< 13.1
31A-S	0-6	**81**	**342**	< 12.8
31B	0-6	**437**	**7,201**	**31**
	6-12	**625**	**6,446**	**22**
	12-18	**492**	**6,445**	**32**
	18-24	**555**	**6,835**	**29**
	24-30	**1,713**	**1,898**	**23**
	30-36	**2,411**	**741**	< 14.9
	36-42	**666**	**1,383**	< 13.8
	42-48	**33**	**185**	< 12.7
32A	0-6	**691**	**14,800**	**46**
	6-12	**658**	**7,767**	**51**
	12-18	**880**	**8,611**	**29**
	18-24	**932**	**12,902**	**35**
	24-30	**99**	**1,079**	**26**
	30-36	**16**	**537**	< 10.8
	36-42	< 10.8	**98**	< 13.1
	42-48	< 11.3	**76**	< 13.1
32A	0-6	**882**	**8,779**	**37**
	6-12	**760**	**9,297**	**35**
	12-18	**1,060**	**10,933**	**55**
	18-24	**1,200**	**18,833**	**35**
	24-30	**332**	**2,202**	< 13.5
	30-36	**280**	**2,408**	**45**
	36-42	**13**	**117**	< 13.6
	42-48	< 12.1	**157**	< 14.1
32B-E	0-6	**75**	**1,452**	< 12.0
33A	0-6	**750**	**11,533**	**49**
	6-12	**686**	**8,748**	**37**
	12-18	**1,040**	**14,700**	**49**
	18-24	**612**	**10,790**	**58**
	24-30	< 13.0	**159**	< 14.5
	30-36	< 10.3	**182**	< 13.2
	36-42	**12**	**1,935**	< 13.2
	42-48	**29**	**651**	< 13.2

Table I.1
Field Screening Average XRF Results for Soil Samples
Cherokee County Superfund Site OU8

Pit ID	Depth (inches	Metal Concentrations (mg/kg)		
		Lead	**Zinc**	**Cadmium**
Residential Soil RSL		*400*	*2,300*	*7.1*
33B	0-6	**682**	**5,566**	**23**
	6-12	**747**	**6,307**	**23**
	12-18	**28**	**117**	<14.4
	18-24	**185**	**734**	<14.1
	24-30	**164**	**433**	<13.1
	30-36	**52**	**127**	<13.8
	36-42	<10.6	**502**	<12.7
	42-48	**19**	**547**	<13.0

Notes:
The values listed are the average of 3 XRF readings for each sample location
< = less than
Bold = indicates detection
ID = identification
Non Bold = represents the method detection limit for samples not detected. Method detection limits were used because results could be up to or equal to the method detection limit without being detected and zero was not considered a correct

APPENDIX J

HUMAN HEALTH RISK ASSESSMENT

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BASELINE HUMAN HEALTH RISK ASSESSMENT FOR THE CHEROKEE COUNTY RAILROADS SITE OPERABLE UNIT 8– LOCATED IN CHEROKEE COUNTY, KANSAS

FINAL

05/14/2015

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95UCL	95% Upper Confidence Limit
ABA	Absolute Bioavailability
ABS_d	Dermal absorption fraction
ABS_{GI}	Bioavailability/gastrointestinal Absorption Factor
ACCLPP	Advisory Committee on Childhood Lead Poisoning Prevention
AF	Absorption Fraction
ALM	Adult Lead Methodology
AT	Averaging Time
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BKSF	Biokinetic Slope Factor
BMDL	Lower Confidence Limit on the Estimate of the Threshold Dose
BW	Body Weight
C_{air}	Concentration of chemical in air
C_{soil}	Concentration of chemical in soil
CDC	Centers for Disease Control and Prevention
CF	Conversion Factor
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
DA	Absorbed Dose
DAD	Dermal Absorbed Dose
DAF	Dermal Adherence Factor
DI	Daily Intake
DQA	Data Quality Assessment
EC	Exposure Concentration
ED	Exposure Duration
EF	Exposure Frequency
EPC	Exposure Point Concentration
ET	Exposure Time
EV	Event Frequency
GM	Geometric Mean
GSD	Geometric Standard Deviation
HHRA	Human Health Risk Assessment
HI	Hazard Index
HIF	Human Intake Factor

HQ	Hazard Quotient
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectroscopy
IEUBK	Integrated Exposure Uptake Biokinetic Model
IR	Intake Rate
IRIS	Integrated Risk Information System
IVBA	*In Vitro* Bioaccessibility
LOAEL	Lowest-observed-adverse-effect level
M_{SD}	Soil to Dust Transfer Factor
NCEA	National Center for Environmental Assessment
NHANES	National Health and Nutrition Evaluation Survey
NOAEL	No-observed-adverse-effect level
NPL	National Priority List
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
P10	Probability of having a blood lead level that exceeds 10 µg/dL
PbB	Geometric Mean Blood Lead Concentration
PbB_0	Background Geometric Mean Blood Lead Concentration
PbC	Lead Concentration
Pb_s	Soil lead concentration
PEF	Particulate Emission Factor
$R_{fetal/maternal}$	Ratio of the blood lead level in a fetus to that of the mother
RAGS	Risk Assessment Guidance for Superfund
RBA	Relative Bioavailability
RfD	Reference Dose
RfC	Reference Concentration
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RSL	Regional Screening Level
SA	Surface Area
SAP	Sampling and Analysis Plan
SF	Slope Factor
TWF	Time Weighting Factor
UCL	Upper Confidence Limit
UFA	Interspecies Uncertainty
UFH	Intraspecies Variability
UFL	LOAEL to NOAEL
UFS	Subchronic to Chronic Extrapolation

UR	Unit Risk
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WOE	Weight of Evidence
XRF	X-ray Fluorescence

1.0 INTRODUCTION

1.1 Purpose

This document is a human health risk assessment (HHRA) for the Cherokee County, Operable Unit 8 (OU8) Railroads site (hereafter referred to as "the site") located in Cherokee County, Kansas. The purpose of this document is to assess the potential risks to humans, both now and in the future, from site-related contaminants present in environmental media, specifically the soils along the historic rail lines.

The results of this assessment are intended to help inform risk managers and the public about potential human risks attributable to site-related contaminants and to help determine if there is a need for action at the site. The methods used to evaluate risks in this assessment are consistent with current United States Environmental Protection Agency (USEPA) guidelines for human health risk assessment at Superfund sites (USEPA 1989, 1991a,b, 1992a, 2002a,b, 2004, 2009a). This HHRA is documented in accordance with the Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual Part D (RAGS Part D) (USEPA 2001) in Appendix G.

1.2 Organization

In addition to this introduction, this report is organized into the following sections:

Section 2	This section provides a description of the site and a review of data that have been collected to characterize the nature and extent of environmental contamination at the site.
Section 3	This section identifies human exposure scenarios of potential concern at the site and identifies chemicals of potential concern (COPCs) for each exposure medium.
Section 4	This section summarizes exposure and risk to humans from non-lead COPCs. This includes a description of the basic methods and data used to evaluate exposure and risk from non-lead chemicals, the estimated cancer and non-cancer risk levels at the site, and a discussion of the uncertainties in the evaluation.
Section 5	This section summarizes human exposure and risk to humans from lead. This includes a description of the basic methods and data used to evaluate exposure and risk, the estimated levels of risk at the site, and a discussion of the uncertainties in the evaluation.

Section 6 This section provides full citations for USEPA guidance documents, site-related documents, and scientific publications referenced in this report.

All tables, figures, and appendices cited in the text are provided at the end of the report.

2.0 SITE CHARACTERIZATION

2.1 Site Location and Description

The Cherokee County Superfund site spans 115 square miles in the southeast corner of Kansas and encompasses the Kansas portion of the Tri-State Mining District. The Tri-State Mining District covers approximately 2,500 square miles in northeast Oklahoma, southwest Missouri, and southeast Kansas. The site is divided into seven sub-sites (Galena, Baxter Springs, Treece, Badger, Lawton, Waco, and Crestline) that are characterized by EPA into eight operable units (OUs). This HHRA focuses on OU8, the rail beds (Figure 2-1). The rail beds in Cherokee County consist of several discontinuous, abandoned lines running throughout the site.

2.2 Soils and Topography

The topography in southeast Kansas is generally gently sloping, except in the river valleys and areas of waste stockpiles and collapsed mine areas where topographic relief is on the order of 50 to 100 feet.

Historically, the ballast used in the railroad beds was composed of chat from surrounding mine waste piles. Currently, the historic railroads that cross through private property exhibit extensive regrowth. The organic layer covering the chat ballast in forested areas is well developed, owing to the almost constant supply of litter from the surrounding vegetation (USEPA 2013a).

2.3 Site History

The Tri-State Mining District was one of the foremost lead-zinc mining areas of the world and provided nearly continuous production from about 1850 until 1970. During this period, the district produced an estimated 500 million tons of ore, with about 115 million tons produced from the Kansas portion of the district. USEPA has listed four mining-related Superfund Sites in the Tri-State Mining District: the Tar Creek, Oklahoma site, the Jasper County, Missouri site, the Newton County, Missouri site, and the Cherokee County, Kansas site (USEPA 2013a).

During the mining years, railroads were constructed in Cherokee County to join conventional large-scale railroads to the individual mining operations. As of 2000, approximately 142 miles of large-scale rail lines exist in Cherokee County. Traditionally, these historic railroads were abandoned when mining operations ceased in that mine.

Several historic rail lines have been addressed during previous remedial actions on properties where they were encountered. Some ballasts may have been completely removed as a result of post-rail line construction activities, such as highway cuts.

2.4 Land Use

Land use within the Cherokee County site has previously been characterized as primarily cropland and pasture with some forest and residential use. Some open land is in use as mine waste repositories associated with remediation efforts in the area. There is a coal-fired power plant on the Spring River near Empire Lake and various light industries in and around Baxter Springs. Chat is processed at both the Baxter Springs and Treece sub-sites and hauled via trucks to various parts of Kansas, Oklahoma, and Missouri (USEPA 2013a).

Land use along the rail beds is primarily considered recreational. Recently, many rail lines were abandoned by railroad companies and reverted back to the property owner through the Surface Transportation Board. Although individual property owners have possession of some of the lines within the site, many are still owned by the railroad companies.

2.5 Basis for Potential Human Health Concern

Mining operations typically generate mine wastes that contain elevated levels of a number of different metals. The primary sources of contamination at the site are: (1) the chat from surrounding mine waste piles used to construct rail beds and (2) deposition from smelting operations. The primary contaminants of interest are lead, cadmium, and zinc. Excess exposures to these metals may cause a range of non-cancer and cancer effects in humans.

2.6 Site Investigations

The Cherokee County Superfund site was placed on the National Priority List (NPL) in 1983. Since that time, numerous site investigations have taken place throughout the site that have resulted in a number of remedial and removal actions as noted in Records of Decision (RODs) and Five Year Review for the site[1]. However, specific investigation of the large-scale rail lines has not occurred previously.

Recently, the USEPA conducted soil sampling along the rail lines within OU8 to support risk assessment activities. Those data are briefly described below.

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[1]A summary of activities completed previously at the Cherokee County Superfund site is available online at: http://www.epa.gov/superfund/eparecovery/cherokee.html.

Soil samples were collected from 34 locations along the historic rail lines (Figure 2-1) in 2013 and 2014 in accordance with the project-specific Sampling and Analysis Plan (SAP) (USEPA 2013a). Samples could not be collected along all areas of the historic rail lines because access was not granted. In brief, test pits were excavated in incremental lifts at 6-inch intervals beginning at the surface to a depth of 4 feet below ground surface (bgs). Soil from each interval was collected in a disposable pan and homogenized for screening using X-ray fluorescence (XRF) spectroscopy. In total, 68 surface (0-6 inches) and 470 subsurface (6-48 inches) soil samples were collected in May, June, and December of 2013 and screened for cadmium, lead, and zinc using XRF spectroscopy. Ten surface soil samples and 56 subsurface soil samples screened using *ex situ* XRF were sent for confirmatory laboratory analysis by inductively coupled plasma-atomic emission spectroscopy (ICP-AES). XRF readings were also made on 33 surface soil samples and 16 subsurface soil samples collected from horizontal locations outward from the center of the rail lines to evaluate the lateral extent of the rail line ballast (herein referred to as "lateral samples"). In addition, 5 surface soil samples and 12 subsurface soil samples were collected from 14 locations for *in vitro* bioaccessibility (IVBA) testing for lead (USEPA 2013a).

USEPA returned to the site in September 2014 to collect an additional 26 surface soil samples along the main rail lines at locations 1, 8, 13-Baxter, 13-Lawton, 14, 15, 17, 24, 25, 26, and 32. All 2014 samples were analyzed by both XRF and ICP analysis for cadmium, lead, and zinc. Two additional surface soil samples were each collected from locations 13-Baxter and 14. One sample from each location was analyzed for concentrations of cadmium, lead, and zinc in the bulk sample. The other sample from each location was sieved using a 60 mesh (250 µm) sieve and analyzed for concentrations of the same metals in the fine fraction. In addition, 26 surface soil samples were collected from 11 locations for IVBA testing for lead.

The analytical data from these sampling events are provided in Appendix A, and summary statistics are provided in Tables 2-1 (main rail line surface soil samples), 2-2 (main rail line subsurface soil samples), and 2-3 (lateral rail lines).

2.7 Data Usability Assessment

XRF versus ICP

As described above, metals in soil were analyzed by two different methods: XRF and ICP. XRF analyses can be performed in the field, whereas ICP analyses are typically done in an analytical laboratory setting. Field-implementable methods like XRF offer the advantages of more rapid turnaround time and lower per-sample cost for analyses, but they also typically require some level of laboratory analytical confirmation to ensure that the results are accurate and compatible with lab analytical data (USEPA 1992b), as was done in this case (see section 2.6). In general, ICP data are considered more reliable for risk assessment purposes than XRF data. Thus, whenever ICP data were available at a sampling location, these data were preferred over XRF data from the same location, and only the ICP data were included in the risk assessment. If only XRF data were available for a sampling location, then the XRF results were included if they were determined to be adequate for use in risk assessment as described below.

The adequacy of XRF data for this site was determined by conducting a Data Quality Assessment (DQA) of XRF data sets (Appendix B). In brief, if the XRF detection frequency was low (<80%), then the XRF detection limit was compared to the level needed for risk assessment purposes to determine whether the XRF analysis had sufficient sensitivity. In addition, the strength of the correlation between paired XRF and ICP results was also evaluated. In order for XRF data for an analyte to be considered for inclusion in the risk assessment, both the detection limit and the correlation with ICP had to be adequate. Based on the DQA in Appendix B, the XRF data for lead and zinc were determined to be adequate for use in this risk assessment. XRF data for cadmium were not adequately correlated with ICP results, and the detection limit for XRF analysis of cadmium was not sufficiently sensitive; thus, XRF analyses for cadmium were not used in this risk assessment.

To make the XRF and ICP data more comparable for use in this HHRA, the XRF data for lead and zinc were adjusted to calculate ICP-equivalent concentrations, using the chemical-specific parameters from the ICP/XRF regressions (see Appendix B for details):

$$[\text{ICP-equivalent concentration}] = a + b \cdot [\text{XRF concentration}]$$

where:

a = Intercept from the ICP/XRF regression line
b = Slope from the ICP/XRF regression line

Main versus Lateral Soil Data

Lateral soil samples were collected at the site to evaluate the nature and extent of contamination. As shown in Tables 2-1, 2-2, and 2-3, average concentrations of lead and zinc are roughly 1- to 3-fold higher along the main rail line than at lateral sampling locations that radiate outward from the main lines. Thus, inclusion of lateral location data in the exposure point concentration (EPC) calculations may “dilute” concentration data for the main line samples. To avoid introducing a low bias into the EPC calculations, data for lateral samples were not used in the HHRA.

Summary of Usable Data

Based on the criteria described above, all data described in Section 2.6 were used in the risk assessment, except as follows:

- If both XRF and ICP data were available for a sample, then only the ICP data were used.
- If only XRF data were available at a location, then the XRF results for lead and zinc were used (after they were adjusted to ICP-equivalent concentrations using the equations presented in Appendix B).
- Data for samples collected from lateral locations were not used to quantify risks in the HHRA.

3.0 EXPOSURE ASSESSMENT

Exposure is the process by which humans come into contact with chemicals in the environment. In general, humans can be exposed to chemicals in a variety of environmental media (e.g., soil, sediment, water, air, food), and these exposures can occur through several pathways (e.g., ingestion, dermal contact, inhalation).

3.1 Site Conceptual Model

Figure 3-1 presents a Conceptual Site Model (CSM) that summarizes the current understanding of how chemical contaminants that have been released to the environment might result in exposure of human receptors at the site.

The primary populations of concern at the site consist of people who may engage in recreational activities at, or in the vicinity of, the historic rail lines. The recreational visitor population represents individuals (adults, adolescents aged 6-16 years, and children aged 0-6 years) who may walk, hike, play, and/or trespass along the historic rail lines in the area and be exposed via direct contact to surface soils along the rail beds. It is expected that this recreational visitor population is mostly area residents. Risks to area residents from exposure at their homes have been evaluated previously and will not be considered as part of this risk assessment for OU8.

It is also possible that there may be some future construction activities along the rail lines, involving "rails to trails" modifications to facilitate recreational use. These activities might involve some shallow soil excavation and light construction. The hypothetical future worker population represents construction/excavation workers who may be exposed via direct contact to surface and subsurface soils along the rail beds.

3.2 Exposure Pathways

Humans may be exposed to site-related contaminants in soils along the rail lines by several different exposure routes (oral, inhalation, dermal). For the risk assessment, each of these pathways is considered "complete". A pathway is considered complete if there is contact between a human receptor and a contaminated environmental medium. However, not all of the potential exposure pathways are likely to be of equal concern. The relative importance depends on the amount of chemical taken into the body by each pathway.

3.2.1 Exposures to Solid Media

Incidental Ingestion of Surface Soil

Even though few people intentionally ingest soil or soil-like materials, recreational visitors and workers who have direct contact with the rail lines at the site might ingest small amounts that adhere to their hands during outdoor activities. In addition, children, especially those under 6 years of age, may ingest soil as a result of frequent hand-to-mouth or object-to mouth behaviors. Incidental ingestion of soil is often one of the most important routes of human exposure at mining sites, so this exposure pathway is evaluated quantitatively in the risk assessment for all receptors.

Dermal Contact with Surface Soil

Recreational visitors and workers who come into contact with contaminated soils may get some of the soil on their skin. Although most metals do not readily cross the skin into the body, dermal exposure to soil is a complete exposure pathway and is evaluated quantitatively in the risk assessment for all receptors. However, quantifying uptake from dermal exposure to soil-borne inorganic lead is not recommended due to the uncertainty in assigning a dermal absorption fraction that would apply to the numerous inorganic forms of lead that are typically found in the environment. Thus, exposure to inorganic lead through dermal contact with soil is not evaluated quantitatively in the risk assessment.

Inhalation of Airborne Soil Particulates

Whenever contaminated soils are exposed at the surface, fine-grained particles of contaminated surface soil may become suspended in air by wind or human disturbance, and humans in the area could inhale those particles. In cases where the soil is disturbed only by wind or walking, the amount of particulate material inhaled from air is generally quite small compared to the amount that is typically assumed for incidental ingestion. Inhalation of particulates suspended by mechanical disturbances (such as excavators) might sometimes be of potential significance relative to oral exposure. In either case, inhalation of particulate matter suspended from soil is a complete pathway and is evaluated quantitatively in the risk assessment for all receptors.

3.2.2 Summary of Exposure Pathways for Quantitative Assessment

Based on the evaluation of potential exposure pathways presented above, the following exposure pathways will be quantitatively evaluated in this risk assessment.

Population	Exposure Pathways
Adult Recreational Visitor	Ingestion of and dermal contact with surface soils Inhalation of soil particulates
Adolescent Recreational Visitor (6-16 years)	Ingestion of and dermal contact with surface soils Inhalation of soil particulates
Child Recreational Visitor (0-6 years)	Ingestion of and dermal contact with surface soils Inhalation of soil particulates
Hypothetical Future Construction Worker	Ingestion of and dermal contact with surface and subsurface soils Inhalation of soil particulates

3.3 Selection of Chemicals of Potential Concern (COPCs)

COPCs are chemicals that exist in the environment at concentrations that might be of potential health concern to humans and that are associated with site-related sources. Based on previous site investigations for other OUs (Dames and Moore 1993, Newfields 2002), the COPCs for this site are cadmium, lead, and zinc.

4.0 EVALUATING EXPOSURE AND RISK FROM NON-LEAD COPCs

4.1 Quantification of Human Exposure

4.1.1 Non-Lead COPCs

Ingestion Exposure

The amount of chemical that is ingested by receptors exposed to site media may be quantified using the following general equation:

$$DI = C_{soil} \cdot (IR / BW) \cdot (EF \cdot ED / AT) \cdot RBA$$

where:

DI	=	Daily intake of chemical (mg per kg of body weight per day).
C_{soil}	=	Concentration of the chemical in the contaminated soil to which the person is exposed (mg/kg).
IR	=	Intake rate of the contaminated environmental medium (kg/day).
BW	=	Body weight of the exposed person (kg).
EF	=	Exposure frequency (days/year). This describes how often a person is likely to be exposed to the contaminated medium over the course of a typical year.
ED	=	Exposure duration (years). This describes how long a person is likely to be exposed to the contaminated medium during their lifetime.
AT	=	Averaging time (days). This term specifies the length of time over which the average dose is calculated. For a chemical which causes non-cancer effects, the averaging time is equal to the exposure duration. For a chemical that causes cancer effects, the averaging time is 70 years as per USEPA (1989) policy.

RBA = Relative bioavailability (see also Section 4.1.5).

Note that the factors EF, ED, and AT combine to yield a factor between zero and one. Values near 1.0 indicate that exposure is nearly continuous over the specified averaging period, while values near zero indicate that exposure occurs only rarely.

For mathematical convenience, the general equation for calculating daily intake can be written as:

$$DI = C_{soil} \cdot HIF \cdot RBA$$

where:

HIF = Human Intake Factor. This term describes the average amount of soil environmental medium contacted by the exposed person each day. The value of HIF is typically given by:

$$HIF = (IR / BW) \cdot (EF \cdot ED / AT)$$

The units of HIF are kg/kg-day for soil.

Dermal Exposure

The amount of a chemical that is absorbed across the skin is referred to as the dermally absorbed dose (DAD). Procedures for estimation of the DAD as outlined in USEPA (2004) are used in this assessment and are described below. For chemicals other than lead, exposure is quantified using an equation of the following general form:

$$DAD = DA_{event} \cdot EF \cdot ED \cdot EV \cdot SA / (BW \cdot AT)$$

where:

DAD = Dermally absorbed dose (mg of chemical per kg of body weight per day).

DA_{event} = Absorbed dose per event (mg of chemical per square centimeter of skin surface area per event). This is medium-specific and is further described below.

EF = Exposure frequency (days/year). This describes how often a person is likely to be exposed to the contaminated medium over the course of a typical year.

ED = Exposure duration (years). This describes how long a person is likely to be exposed to the contaminated medium during their lifetime.

EV = Event frequency (events/day). This describes the number of times per day a person comes in contact with a contaminant in soil.

SA = Surface area (cm^2). This describes the amount of skin exposed to the contaminated media.

BW = Body weight of the exposed person (kg).

AT = Averaging time (days). This term specifies the length of time over which the average dose is calculated.

For contaminants in soil, DA_{event} is estimated as follows:

$$DA_{event} = C_{soil} \cdot CF_s \cdot DAF \cdot ABS_d$$

where:

C_{soil} = Chemical concentration in soil (mg of chemical per kg of soil).

CF_s = Conversion factor for soil (10^{-6} kg/mg).

DAF = Dermal adherence factor (mg of soil per square centimeter of skin surface area per event). This describes the amount of soil that adheres to the skin per unit of surface area.

ABS_d = Dermal absorption fraction (unitless). This value is chemical-specific and represents the contribution of absorption of a chemical across a person's skin from soil to the systemic dose.

Combining these equations yields the following:

$$DAD = C_{soil} \cdot CF \cdot DAF \cdot ABS_d \cdot EF \cdot ED \cdot EV \cdot SA / (BW \cdot AT)$$

For mathematical convenience, the general equation for calculating DAD can be written as:

$$DAD = C_{soil} \cdot ABS_d \cdot HIF_{soil}$$

where:

$$HIF_{soil} = CF \cdot AF \cdot EF \cdot ED \cdot EV \cdot SA) / (BW \cdot AT)$$

The units of HIF are kg/kg-day for soil.

Inhalation Exposure

Inhalation exposures are evaluated in accordance with the inhalation dosimetry methodology presented in USEPA's Risk Assessment Guidance for Superfund (RAGS) Part F: Inhalation Risk Assessment (USEPA 2009a).

In accordance with USEPA (2009a), the human intake equation does not include an inhalation rate (m^3/day) or body weight because the amount of the chemical that reaches the target site is not a simple function of these factors. Instead, the interaction of the inhaled contaminant with the respiratory tract is affected by factors such as species-specific relationships between exposure concentrations or deposited/delivered doses and physiochemical characteristics of the inhaled contaminant (USEPA 2009a). Therefore, the inhaled exposure concentration (EC) for chronic exposures is calculated as:

$$EC = C_{air} \cdot (ET \cdot EF \cdot ED / AT)$$

where:

EC = Exposure concentration (µg/m^3). This is the time-weighted concentration based on the characteristics of the exposure scenario being evaluated.

C_{air} = Concentration of the chemical in air (µg/m^3) to which the person is exposed.

ET = Exposure time (hours/day). This describes how long a person is likely to be exposed to the contaminated medium over the course of a typical day.

EF = Exposure frequency (days/year). This describes how often a person is likely to be exposed to the contaminated medium over the course of a typical year.

ED = Exposure duration (years). This describes how long a person is likely to be exposed to the contaminated medium during their lifetime.

AT = Averaging time (days). This term specifies the length of time over which the time-weighted average concentration is calculated.

For mathematical convenience, the general equation for exposure concentration can be written as:

$$EC = C_{air} \cdot TWF$$

where:

TWF = Time-weighting factor (unitless)

The value of TWF is given by:

$$TWF = ET \cdot EF \cdot ED / AT$$

4.1.2 Exposure Units

An exposure unit or exposure area is a location where a receptor (e.g., recreational visitor, worker) may be exposed to environmental media. Defining an exposure unit depends on a consideration of the likely activity patterns of the exposed receptors.

For the recreational visitor population, exposure units are defined based on assumed recreational use patterns that are influenced by accessibility and proximity to residential areas or play areas. On this basis, two exposure units were evaluated for recreational visitors:

- High-frequency recreational use areas: these locations include areas where the historic rail lines run close to residential properties and/or play areas (sample locations 17/18, 24/25, 13-Baxter, and 14/15 as shown in Figure 2-1).

- Low-frequency recreational use areas: these locations include agricultural and wooded areas with limited human exposure potential (all other locations not identified as high-frequency recreational use in Figure 2-1).

For the worker population, it is assumed that future construction/excavation activities could occur along any of the rail lines at any location. Thus, the entire site is considered as a single exposure unit for evaluation of potential future exposures of construction/excavation workers.

4.1.3 Human Exposure Parameters

There are differences among individuals in intake rates, body weights, exposure frequencies, and exposure durations that determine the actual extent of chemical exposure. Typically, the HHRA provides estimates of intakes that are "average" or are otherwise near the central portion of the range, and on intakes that are near the upper end of the range (e.g., the 95th percentile). These two exposure estimates are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME), respectively.

Tables 4-1, 4-2, and 4-3 list the CTE and RME exposure parameters and resultant HIF values used in this assessment for high-frequency recreational visitor populations, low-frequency recreational visitor populations, and a construction worker population. Some of the values are informed by site information, some are based on USEPA default guidelines, and others are based on professional judgment or are estimated by extrapolation from other sites. The HIF values are summarized in Table 4-4.

4.1.4 Exposure Point Concentrations

Exposure to a chemical within an exposure area is assumed to be related to the arithmetic mean concentration within that exposure area. Since the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, the USEPA recommends that the 95% upper confidence limit (95UCL) of the arithmetic mean at each exposure point be used as the EPC when calculating exposure and risk at that location (USEPA 1992a).

The mathematical approach that is most appropriate for computing the 95UCL of a data set depends on a number of factors, including the number of data points available, the shape of the distribution of the values, and the degree of censoring (USEPA 2002a). Because of the complexity of this process, the USEPA Technical Support Center has developed a software application called ProUCL (USEPA 2013b) to assist in the estimation of 95UCL values.

ProUCL calculates 95UCLs for a data set using several different strategies and recommends the 95UCL that is considered preferable based on the properties of the data set. A minimum of five samples and two distinct detected values is required to calculate 95UCLs in ProUCL. If the minimum data requirements for ProUCL are not met, then the EPC is set equal to the maximum detected value. If ProUCL provides more than one "recommended" 95UCL to use (e.g., Chebyshev or Bootstrap), the higher recommended value is used as the EPC. Detailed results from ProUCL can be found in Appendix C.

Approach for Non-lead COPCs in Air

No site-specific data are available on particulate levels in air at the site. In the absence of measured values, the concentration of contaminants in air that would occur due to soil-to-air transfer due to wind or human disturbance was estimated using the following equation:

$$C_{air} = C_{soil} / PEF$$

where:

C_{air} = Concentration of contaminant in air (mg/m^3)
C_{soil} = Concentration of contaminant in soil (mg/kg)
PEF = Particulate emission factor (m^3 of air per kg of soil)

In the absence of additional data, the default PEF of 1.36×10^9 m^3/kg presented in USEPA (2002b) was used in this risk assessment for evaluation of inhalation exposures by recreational visitors. This PEF value addresses only windborne dust emissions and does not consider emissions from traffic or other forms of mechanical disturbance, which could lead to a greater level of exposure. A calculated site-specific PEF of 3.2×10^6 m^3/kg was used to evaluate exposures of construction workers. This value is intended to address windborne dust emissions and emissions from truck traffic on unpaved site soils, which typically contribute the majority of dust emissions during construction activities (USEPA 2002b). Appendix D presents the derivation of the construction worker PEF value.

4.1.5 Relative Bioavailability (RBA) of Non-Lead Metals in Soil

RBA is the ratio of the gastrointestinal absorption of a chemical from a site medium (e.g., soil) compared to the absorption of that chemical that occurred in the toxicity study used to derive the toxicity factors for the chemical. In general, metals in soil or sediment exist in the form of mineral particles that are not rapidly solubilized in gastrointestinal fluids when ingested, while toxicity studies often utilize readily soluble forms of the test chemical. Thus, oral RBA values for metals in soil are often less than 1.0. However, lacking adequate RBA data for cadmium and zinc, the RBA values for these chemicals are conservatively assumed to be 1.0.

4.2 Toxicity Assessment

4.2.1 Overview

The toxicity assessment identifies what adverse health effects are associated with exposure to a given chemical, and how the appearance of these adverse effects depends on exposure level (dose-response). In addition, the toxic effects of a chemical frequently depend on the route of exposure (oral, inhalation, dermal) and the duration of exposure (subchronic, chronic, or lifetime). Thus, a full description of the toxic effects of a chemical includes a listing of what adverse health effects the chemical may cause, and how the occurrence of these effects depends upon dose, route, and duration of exposure.

The toxicity assessment process is usually divided into two parts: the first characterizes and quantifies the non-cancer effects of the chemical, while the second addresses the cancer effects of the chemical. This two-part approach is employed because there may be major differences in the time-course of action and the shape of the dose-response curve for cancer and non-cancer effects.

<u>Non-Cancer Effects</u>

Essentially all chemicals can cause adverse health effects if given at a high enough dose. However, when the dose is sufficiently low, typically no adverse effect is observed. Thus, in characterizing the non-cancer effects of a chemical, the key parameter is the threshold dose at which an adverse effect first becomes evident. Doses below the threshold are considered to be safe, while doses above the threshold may cause an effect.

The threshold dose is typically estimated from toxicological data (derived from studies of humans and/or animals) by finding the highest dose that does not produce an observable adverse effect, and the lowest dose which does produce an effect. These are referred to as the "no-observed-adverse-effect level" (NOAEL) and the "lowest-observed-adverse-effect level" (LOAEL), respectively. The threshold is presumed to lie in the interval between the NOAEL and the LOAEL. Alternatively, dose-response data for the critical effect may be modeled using USEPA's Benchmark Dose Modeling Software to obtain the lower confidence limit on the estimate of the threshold dose (BMDL). In order to be conservative (health protective), non-cancer risk evaluations are not based directly on the threshold exposure level, but on a value referred to as the Reference Dose (RfD) for oral exposures or Reference Concentration (RfC) for inhalation exposures. The RfD and RfC are estimates (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA 1989).

The RfD and RfC values are derived from a BMDL or NOAEL (or a LOAEL if a reliable NOAEL is not available) by dividing by an "uncertainty factor". Factors accounting for several sources of uncertainty (e.g., interspecies uncertainty [UFA], intraspecies variability [UFH], subchronic to chronic extrapolation [UFS], LOAEL to NOAEL [UFL], etc.) are combined into a single uncertainty factor that is applied to the RfD or RfC value. If the data are from studies in humans and the observations are considered to be very reliable, then the uncertainty factor may be as small as 1.0. However, the uncertainty factor is normally at least 10, and can be much higher if the data are limited. The effect of dividing the BMDL, NOAEL, or LOAEL by an uncertainty factor is to ensure that the RfD or RfC is not higher than the threshold level for adverse effects. Thus, there is always a "margin of safety" built into RfD and RfC values. Exposures higher than the RfD or RfC may carry some risk, but because of the margin of safety, an exposure above the RfD or RfC does not mean that an effect will necessarily occur (USEPA 1989).

Cancer Effects

For cancer effects, the toxicity assessment process has two components. The first is a qualitative evaluation of the weight of evidence (WOE) that the chemical does or does not cause cancer in humans. Previously, this evaluation was performed by the USEPA using the system summarized below:

WOE	Meaning	Description
A	Known human carcinogen	Sufficient evidence of cancer in humans.
B1	Probable human carcinogen	Suggestive evidence of cancer incidence in humans.
B2	Probable human carcinogen	Sufficient evidence of cancer in animals, but lack of data or insufficient data in humans.
C	Possible human carcinogen	Suggestive evidence of carcinogenicity in animals
D	Cannot be evaluated	No evidence or inadequate evidence of cancer in animals or humans
E	Not carcinogenic to humans	Strong evidence that it does not cause cancer in humans

More recently, USEPA developed a revised classification system for characterizing the weight of evidence for carcinogens (USEPA 2005). However, this system has not yet been implemented for a number of chemicals, so the older classification scheme is retained for use in this assessment.

For chemicals that are classified in Group A, B1, B2, or C, the second part of the toxicity assessment is to describe the carcinogenic potency of the chemical. This is done by quantifying how the number of cancers observed in exposed animals or humans increases as the dose increases. Typically, it is assumed that the dose-response curve for cancer has no threshold (i.e., that any dose above zero presents an increase cancer risk). Thus, the most convenient descriptor of cancer potency is the slope of the dose-response curve at low doses (where the slope is assumed to be linear). This is referred to as the Slope Factor (SF), which has dimensions of risk of cancer per unit dose.

Estimating the cancer SF is often complicated by the fact that observable increases in cancer incidence usually occur only at relatively high doses, frequently in the part of the dose-response curve that is no longer linear. Thus, it is necessary to use mathematical models to extrapolate from the observed high-dose data to the desired (but un-measurable) slope at low dose. In order to account for the uncertainty in this extrapolation process, USEPA typically chooses to employ the upper 95UCL of the slope as the SF. That is, there is a 95 percent probability that the true cancer potency is lower than the value chosen for the SF. This approach ensures that there is a margin of safety in cancer risk estimates.

For inhalation exposures, cancer risk is characterized by an inhalation Unit Risk (UR) value. This value represents the upper-bound excess lifetime cancer risk estimated to result from continuous lifetime exposure to a chemical at a concentration of 1 $\mu g/m^3$ in air.

4.2.2 Human Toxicity Values

Toxicity values (RfD, RfC, SF, and UR values) that have been established by the USEPA are listed in an on-line database referred to as "IRIS" (Integrated Risk Information System) (USEPA 2015a). Other toxicity values are available as interim recommendations from the USEPA's Superfund Technical Assistance Center operated by the National Center for Environmental Assessment (NCEA). Selection of toxicity values (RfD, RfC, SF, and UR values) for use in this risk assessment follows the hierarchy for use in human health risk assessment at Superfund sites as described in USEPA (2003a). A table of toxicity values derived following this hierarchy is maintained by USEPA and is periodically updated by Oak Ridge National Laboratories (USEPA 2015b). This is generally referred to as the Regional Screening Level (RSL) table.

All toxicity values used in this assessment were taken from the most recent version (January 2015) of the RSL tables. Tables 4-5 and 4-6 shows the toxicity values used for evaluation of human health risks from COPCs at this site. Points to note regarding the data in this table are listed below (see also the User's Guide to the RSL table):

- Two oral RfD values are available for cadmium, depending on exposure medium (diet, water). The value for "diet" is assumed to apply to soil.

- The construction worker scenario is limited to an exposure duration of 1 year, and is thus, subchronic. In the absence of subchronic RfD/RfC values for cadmium and zinc, the chronic toxicity values for these metals were used.

- Health effects associated with exposure to inorganic lead and compounds include, but are not limited to, neurotoxicity, developmental delays, hypertension, impaired hearing acuity, impaired hemoglobin synthesis, and male reproductive impairment. Lead is known to bioaccumulate in the body, primarily in the skeleton. Lead body burdens vary significantly. Thus, based on current knowledge of lead pharmacokinetics, and an apparent lack of a threshold effect, no risk values have been derived for lead. Risks from exposure to lead will be evaluated using toxicokinetic models as described in Section 5.0.

4.3 Risk Characterization Approach

4.3.1 Non-Cancer Effects

The potential for non-cancer effects is evaluated by comparing the estimated exposure concentration for a receptor over a specified time period to a reference value that represents the exposure below which it is unlikely for even sensitive populations to experience adverse health effects (USEPA 1989). This ratio of exposure to toxicity is called a Hazard Quotient (HQ). When a receptor is exposed to a COPC by more than one route, or is exposed to more than one COPC, these values may be summed to yield a Hazard Index (HI). If the HQ or HI value is equal to or less than one, then it is believed that there is no appreciable risk that non-cancer health effects will occur. If an HQ or HI exceeds one, then there is some possibility that non-cancer effects may occur, although an HQ or HI above one does not indicate that an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all toxicity values (see Section 4.2.1).

Ingestion Exposures

For most chemicals, the potential for non-cancer effects following ingestion exposure is evaluated by comparing the estimated daily intake of the chemical over a specific time period with the RfD for that chemical derived for a similar exposure period, as follows (USEPA 1989):

$$HQ = DI / RfD$$

where:

DI	=	Daily intake (mg/kg-day)
RfD	=	Reference Dose (mg/kg-day)

Dermal Exposures

For most chemicals, the potential for non-cancer effects following dermal exposure is evaluated by comparing the estimated absorbed dose of the chemical over a specific time period with the RfD for that chemical derived for a similar exposure period, as follows (USEPA 1989):

$$HQ = DAD / RfD_{ABS}$$

where:

DAD	=	Dermal absorbed dose (mg/kg-day)
RfD_{ABS}	=	Absorbed Reference Dose (mg/kg-day)
		$RfD_{ABS}=RfD \cdot ABS_{GI}$

The ABS_{GI} term is unitless, is chemical-specific, and is applied to the available oral toxicity values to account for the absorption efficiency of an administered dose across the gastrointestinal tract and into the bloodstream.

Inhalation Exposures

For inhalation exposures, the potential for non-cancer effects is evaluated by comparing the time-weighted exposure concentration (EC) over a specific time period to the appropriate inhalation RfC for that chemical, as follows (USEPA 2009a):

$$HQ = EC / RfC$$

where:

EC = Exposure concentration (mg/m^3)
RfC = Reference Concentration (mg/m^3)

Evaluating Risks Across Pathways

If an individual is exposed to more than one chemical, then a screening-level estimate of the total non-cancer risk is derived simply by summing the HQ values for that individual. This total is referred to as the HI. If the HI value is less than one, then non-cancer risks are not expected from any chemical, alone or in combination with others.

4.3.2 Cancer Effects

The excess risk of cancer from exposure to a chemical is described in terms of the probability that an exposed individual will develop cancer because of that exposure. Excess cancer risks are summed across all carcinogenic chemicals and all exposure pathways that contribute to exposure of an individual in a given population. The level of total cancer risk that is of concern is a matter of personal, community, and regulatory judgment. In general, the USEPA considers excess cancer risks that are below 1E-06 to be so small as to be negligible, and risks above 1E-04 to be sufficiently large that some sort of remediation is desirable[2]. Excess cancer risks that range between 1E-04 and 1E-06 may be acceptable (USEPA 1991b), although this is evaluated on a case-by-case basis. USEPA may determine that risks lower than 1E-04 are not sufficiently protective and warrant remedial action. Cancer risks for each chemical are calculated as described below.

Ingestion Exposures

The excess risk of cancer from ingestion exposure to a chemical is calculated as follows (USEPA 1989):

$$\text{Excess Cancer Risk} = 1 - \exp(-DI_L \cdot SF)$$

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[2]Note that excess cancer risk can be expressed in several formats. A cancer risk expressed in a scientific notation format as 1E-06 is equivalent to 1 in 1,000,000 or 10^{-6}. Similarly, a cancer risk of 1E-04 is equivalent to 1 in 10,000or 10^{-4}. For the purposes of this document, all cancer risks are presented in a scientific notation format (*i.e.,* 1E-06).

where:

DI_L = Daily intake, averaged over a lifetime (mg/kg-day)
SF = Slope Factor $(\text{mg/kg-day})^{-1}$

In most cases (except when the product of $DI_L \cdot SF$ is larger than about 0.01), this equation may be approximated by the following:

$$\text{Excess Cancer Risk} = DI_L \cdot SF$$

Dermal Exposures

The excess risk of cancer from dermal exposure to a chemical is calculated as follows (USEPA 2004):

$$\text{Excess Cancer Risk} = DAD_L \cdot SF_{ABS}$$

where:

DAD_L = Dermal absorbed dose, averaged over a lifetime (mg/kg-day)
SF_{ABS} = Absorbed Slope Factor $(\text{mg/kg-day})^{-1}$

$$SF_{ABS} = SF/ABS_{GI}$$

Inhalation Exposures

The excess risk of cancer from inhalation exposure is calculated based on inhalation UR values, as follows (USEPA 2009a):

$$\text{Excess Cancer Risk} = EC \cdot CF \cdot UR$$

where:

EC = Exposure concentration (mg/m^3)
CF = Conversion factor (µg/mg)
UR = Unit Risk $(\mu\text{g/m}^3)^{-1}$

4.4 Results

Detailed calculations of exposure and risk from cadmium and zinc for each exposure scenario are presented in Appendix E. Findings are summarized in Table 4-7. Inspection of this table, supplemented with the detailed calculations presented in Appendix E, reveal the following main conclusions.

<u>Recreational Visitors</u>

High-Frequency Use Areas

As shown in Table 4-7, risks to a child, adolescent, or adult person trespassing or hiking along the rail lines within areas characterized as high-frequency use areas appear to be within USEPA guidelines (i.e., HI <1 and cancer risk <1E-06).

Low-Frequency Use Areas

As shown in Table 4-7, risks to a child, adolescent, or adult person trespassing or hiking along the rail lines within areas characterized as low-frequency use areas appear to be within USEPA guidelines.

<u>Construction Workers</u>

As shown in Table 4-7, risks to a hypothetical future construction worker appear to be within USEPA guidelines.

4.5 Uncertainty Assessment

Quantitative evaluation of the risks to humans from environmental contamination is frequently limited by uncertainty regarding a number of key data items, including concentrations in the environment, the true level of human contact with contaminated media, and the true dose-response curves for non-cancer and cancer effects in humans. This uncertainty is usually addressed by making assumptions or estimates for uncertain parameters based on whatever limited data are available. Because of these assumptions and estimates, the results of risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment. The following sections review the main sources of uncertainty in the risk calculations performed at the site.

4.5.1 Uncertainties in Exposure Assessment

Uncertainties from Chemicals Not Evaluated

Previous investigations at the Cherokee County Superfund site have identified cadmium, lead, and zinc as the three chemicals of primary concern at the site. Data on other analytes in rail line soils are not available in the 2013/2014 data sets used in this HHRA, and thus, no conclusions are drawn regarding the potential risks from other analytes.

Uncertainties in EPCs

All soil sampling locations that were identified as being located near residential or play areas were considered as a single high-frequency use exposure unit. Likewise, all other sampling locations were considered as a single low-frequency use exposure unit. If a person were to choose to regularly visit only one certain area along the rail lines over the course of his or her entire exposure duration, then the corresponding exposure may be higher or lower than estimated. Similarly, a construction worker was assumed to be exposed across the site over the course of his or her exposure duration. If a worker were to predominantly spend time at a single location, then the corresponding exposure may be higher or lower than estimated.

USEPA (1989, 1992a) recommends that the EPC be based on the 95UCL. When data are plentiful and inter-sample variability is not large, the UCL may be only slightly greater than the arithmetic mean. However, when data are sparse or are highly variable, the 95UCL may be substantially greater than the mean. Such cases reflect the substantial uncertainty that exists when data are sparse or highly variable, and the approaches used in the HHRA are intended to ensure that risk is not underestimated.

In the case of inhalation risks, measured air data were not available so airborne concentrations were estimated using a screening level soil-to-air transfer model. In general, such predicted values have high uncertainty compared to measured values, so the actual concentrations of metals in airborne dust are uncertain, and true values might be either higher or lower than calculated.

Soil samples used in this assessment were not sieved. It is generally expected that small soil particles (<250 µm, "fine fraction") are more likely to adhere to the hands (or other objects that may be mouthed) than coarse particles (2 mm) and be subsequently ingested (USEPA 2000, 2007). Studies of other sites have suggested enrichment of metal concentrations in the fine fraction (Kim et al. 2011; Luo et al. 2011; Madrid et al. 2008; Pye et al. 2007; Ljung et al. 2006, 2007). Cadmium and zinc concentrations in the bulk and fine fractions of two 2014 surface soil samples are summarized in Table 4-8. As shown in the table, concentrations are higher in the fine fractions compared to the bulk samples. Thus, EPCs calculated using data from bulk samples (rather than the <250 μm fraction) may underestimate actual exposure.

Uncertainties in Human Exposure Parameters

Many of the exposure parameters used in the HHRA are not known with certainty and must be estimated from limited data or knowledge. In general, when exposure data were limited or absent, the exposure parameters were chosen to be conservative (health-protective) and unlikely to underestimate actual exposure and risk.

Uncertainties in Chemical Absorption (RBA)

The risk from an ingested chemical depends on how much of the ingested chemical is absorbed from the gastrointestinal tract into the body. This issue is especially important for metals in soil at mining sites, because some of the metals may exist in poorly absorbable forms, and failure to account for this may result in a substantial overestimation of exposure and risk. In the absence of data, the default approach is to assume that the RBA is 100% for most metals. Use of this default assumption is likely to overestimate the true risk with the magnitude of the error depending on the true RBA value.

4.5.2 Uncertainties in Toxicity Values

Toxicity information for many chemicals is often limited. Consequently, there are varying degrees of uncertainty associated with toxicity values (i.e., oral SF, RfD, RfC, inhalation UR). For example, uncertainties can arise from the following sources:

- Extrapolation from animal studies to humans
- Extrapolation from high dose to low dose
- Extrapolation from continuous exposure to intermittent exposure
- Limited or inconsistent toxicity studies

Because of the conservative methods that USEPA uses in dealing with the uncertainty in toxicity factors, it is much more likely that the uncertainty will result in an overestimation rather than an underestimation of risk.

4.5.3 Uncertainties in Risk Estimates

Because risk estimates for a chemical are derived by combining uncertain estimates of exposure and toxicity (see above), the risk estimates for each chemical are also uncertain. Additional uncertainty arises from the issue of how to combine risk estimates across different chemicals. In some cases, the effects caused by one chemical do not influence the effects caused by other chemicals. In other cases, the effects of one chemical may interact with effects of other chemicals, causing responses that are approximately additive, greater than additive (synergistic), or less than additive (antagonistic). In most cases, available toxicity data are not sufficient to define what type of interaction is expected; therefore, USEPA generally assumes that effects are additive for non-carcinogens that act on the same target tissue and for carcinogens (all target tissues). Because documented cases of synergistic interactions between chemicals are relatively uncommon, this approach is likely to be reasonable for most chemicals.

For non-carcinogens, summing HQ values across different chemicals is properly applied only to compounds that induce the same effect by the same mechanism of action. Consequently, summation of HQ values for compounds that are not expected to include the same type of effects or that do not act by the same mechanisms could overestimate the potential for effects. Thus, the HI values in this report, which sum HQ values across multiple metals without regard to target organ or mechanism of action, may overestimate the true level of non-cancer hazard.

5.0 EVALUATING EXPOSURE AND RISK FROM LEAD

5.1 Overview

Risks from lead are evaluated using a somewhat different approach than for most other chemicals. First, because lead is widespread in the environment, exposure can occur from many different sources. Thus, lead risks are usually based on consideration of total exposure (all sources) rather than just site-related sources. Second, because epidemiological studies of lead exposures and resultant health effects in humans have not established a blood lead level below which adverse effects are not observed, lead exposures and risks are typically assessed by calculating the levels of lead that may occur in the blood of exposed populations and comparing these to blood lead levels of potential health concern (USEPA 1994a, 1998a). For convenience, the concentration of lead in blood is usually abbreviated "PbB", and is expressed in units of µg/dL.

Blood Lead Level of Concern

Health effects from elevated blood lead levels are greatest for the developing nervous systems of young children or the fetus of pregnant women. There are several reasons for this, including the following: (1) young children typically have higher exposures (per unit body weight) to lead-contaminated media than adults, (2) young children typically have higher lead absorption rates than adults, and (3) young children and fetuses are generally more susceptible to effects of lead than are adults (NTP 2012). By protecting the most sensitive receptor, it is assumed that all other receptors will be protected. After a thorough review of all the data, USEPA has established a goal that there should be no more than a 5% chance that a child will have a blood lead value above 10 µg/dL (USEPA 1994a, 1998a). For convenience, the probability of a blood lead value exceeding 10 µg/dL is referred to as P10.

Recently, the Centers for Disease Control and Prevention (CDC) identified 5 µg/dL as a "reference value" for blood lead in children[3] (CDC 2012). This concentration corresponds to the 97.5th percentile of blood lead levels in children in the United States. USEPA's Office of Superfund Remediation and Technology Innovation (OSRTI) is in the process of evaluating the CDC recommendations and implications for Superfund risk assessments, in close coordination and consultation with the CDC and the Agency for Toxic Substances and Disease Registry (ATSDR). Until that reassessment is complete, USEPA is continuing to use a P10 value of 5% as the health based goal to assess risk from exposure to lead at Superfund sites. Although the

[3] http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm

value of 10 µg/dL is based on studies in young children, it is generally assumed that the same value is applicable to a fetus *in utero* (USEPA 2003b).

5.2 Exposure Unit

As described above, an exposure unit is an area within which a receptor is likely to spend time and be exposed to COPCs. As discussed in Section 4, three exposure units were evaluated in this risk assessment: high-frequency recreational use areas, low-frequency recreational use areas, and the entire site for workers.

5.3 Exposure Point Concentrations

The EPCs for lead were quantified differently than the EPCs for non-lead metals described above. Instead, the mean concentration of lead in soil for each exposure point was used as the EPC, in accordance with USEPA (1994a, 2003a) guidance. For the high- and low-frequency recreational use areas, these were the mean lead concentrations based on surface soil samples collected from respective locations within each category. For evaluation of lead exposures for hypothetical future construction workers, the mean lead concentration across all sampling depths and sampling locations was used as the EPC, based on the assumption that subsurface soils could potentially be excavated and be available for exposure.

5.4 Lead Models and Parameters

The USEPA recommends the use of toxicokinetic models to correlate blood lead concentrations with exposure and adverse health effects. Specifically, the USEPA recommends the use of the Integrated Exposure Uptake Biokinetic (IEUBK) model to evaluate exposures from lead-contaminated media in children in a residential setting (USEPA 1994a,b, 1998a), and the Adult Lead Methodology (ALM) to evaluate potential risks from lead exposure in non-residential areas (USEPA 2003b). Both the IEUBK model and the ALM can be used to predict blood lead concentrations in exposed individuals and to estimate the probability of a blood lead concentration exceeding USEPA's level of concern (10 µg/dL), as described below.

5.4.1 Integrated Exposure Uptake Biokinetic (IEUBK) Model

Lead risks for the child recreational visitors were calculated using the IEUBK model. The IEUBK model developed by USEPA (1994a) predicts the likely range of blood lead levels in a population of young children (aged 0-84 months) exposed to a user-specified set of environmental lead levels (USEPA 1994a). This model allows users to input data on the levels of lead in soil, dust, water, air, and diet at a particular location as well as data on the amounts of these media ingested or inhaled by a child living at that location. All of these inputs to the IEUBK model are central tendency point estimates. These point estimates are used to calculate an estimate of the central tendency (the geometric mean) of the distribution of blood lead values that might occur in a population of children exposed to the specified conditions. Assuming that the distribution is lognormal, and given (as input) an estimate of the variability between different children (this is specified by the geometric standard deviation or GSD), the model calculates the expected distribution of blood lead values, and estimates the probability that any random child exposed to the site conditions might have a blood lead value over 10 µg/dL under the user-specified exposure conditions.

5.4.2 Adult Lead Methodology (ALM)

Lead risks for adult recreational visitors and adolescent and adult trespassers are calculated using the ALM. The ALM (USEPA 2003b), based on the work of Bowers et al. (1994), predicts the blood lead level in a person with a site-related lead exposure by summing the "baseline" blood lead level (PbB_0) (that which would occur in the absence of any site-related exposures) with the increment in blood lead that is expected as a result of increased exposure due to contact with lead-contaminated site media. The latter is estimated by multiplying the average daily absorbed dose of lead from site-related exposure by a "biokinetic slope factor" (BKSF). Thus, the basic equation for exposure to lead in soil is:

$$PbB = PbB_0 + Pb_S \cdot BKSF \cdot IR_S \cdot AF_S \cdot EF_S / AT$$

where:

PbB = Geometric mean blood lead concentration (µg/dL) in women of child-bearing age) that are exposed at the site

PbB_0 = "Background" geometric mean blood lead concentration (µg/dL) in women of child-bearing age in the absence of exposures to the site (default value from USEPA 2009b)

Pb_S = Soil lead concentration (µg/g) (appropriate average concentration for individual)

$BKSF$ = Biokinetic slope factor (µg/dL blood lead increase per µg/day lead absorbed)

IR_S = Intake rate of soil, including both outdoor soil and indoor soil-derived dust (g/day)

AF_S = Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless)

EF_S = Exposure frequency for contact with assessed soils and/or dust derived in part from these soils (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposure

AT = Averaging time; the total period during which soil contact may occur; 365 days/year for continuing long-term exposures

Evaluation of risk for adult visitors to the site focuses on estimating the risk that fetal blood lead values may exceed 10 µg/dL among pregnant women who visit the site for recreational purposes. The ALM accomplishes this by estimating the blood lead concentration of a pregnant woman using that value to estimate the 95th percentile of the distribution of possible fetal blood values. Specifically, the geometric mean (GM) blood lead concentration in an adult woman is then combined with the ratio of fetal blood lead to maternal blood lead to derive the GM blood lead value for the fetus. Available data suggest that the ratio of the blood lead level in a fetus to that of the mother ($R_{fetal/maternal}$) is approximately 0.9 (Goyer 1990). In summary, the 95th percentile of the predicted distribution of fetal blood lead levels is calculated by the following equation (Aitchison and Brown 1957):

$$95^{th} \text{ percentile } PbB_{fetal} = GM_{maternal} \cdot PbB \cdot GSDi^{1.645} \cdot R_{fetal/maternal}$$

The ALM then calculates the full distribution of likely fetal blood lead values in the population of exposed individuals by assuming the distribution is lognormal with a specified individual geometric standard deviation (GSDi). This allows the ALM to derive the 95th percentile blood lead for the fetus.

5.4.3 Evaluation of Intermittent Exposures

Both the IEUBK model and the ALM are designed to evaluate exposures that are approximately continuous (e.g., 365 days/year). However, the non-residential exposure scenarios of concern at the site (trespasser and recreational visitor) are intermittent, occurring less than continuously (see Tables 4-1, 4-2, and 4-3).

When exposure is intermittent rather than continuous, the IEUBK and ALM models can still be used by adjusting the site-related exposure concentration that occurs during the exposure interval to an equivalent continuous exposure concentration that yields the same total yearly exposure. However, this adjustment is reasonable only in cases where exposure occurs with a relatively constant frequency over a time interval long enough to establish an approximately steady-state response (USEPA 2003c). Short-term exposures are not suitable for approximations as continuous exposures. In order to prevent applications of the lead models to exposure scenarios where an adjustment from intermittent to continuous exposure is not appropriate, USEPA (2003c) recommends that these models only be applied to exposures that satisfy two criteria:

- The exposure frequency during the exposure interval is at least 1 day per week

- The duration of the exposure interval is at least three consecutive months

All of the proposed intermittent exposure scenarios evaluated at the site meet both of these requirements. Consequently, exposure to recreational visitors and trespassers may be evaluated by extrapolating from estimated intermittent to equivalent continuous exposure concentration, as described below.

IEUBK Model

For the IEUBK model, the frequency-adjusted exposure concentration was calculated as follows:

$$PbC_{weighted} = PbC_{site} \cdot (EF_{Pb}/ED_{Pb}) + PbC_{residence} \cdot ([ED_{Pb}-EF_{Pb}]/ED_{Pb})$$

where:

$PbC_{weighted}$	=	Time-weighted average media lead concentration for recreational lead exposures (µg/g)
PbC_{site}	=	Average lead concentration in site soil (µg/g)
EF_{Pb}	=	Exposure frequency for recreational lead exposures (days/year), 1 day/ week · 24 weeks = 24 days for low frequency scenario and 4 days/week · 24 weeks = 96 days for high frequency scenario)
ED_{Pb}	=	Exposure duration for continuous lead exposures (days/year), 7 days/week · 24 weeks = 168 days

$PbC_{residence}$ = Background soil lead concentration (e.g., average background soil lead concentration) (µg/g)

Since the people working or recreating at the site are most likely those who reside nearby, it is assumed that site soil will be tracked back to the residence. The time-weighted soil concentration was used with the default M_{SD} to derive an indoor dust lead exposure concentration that reflects track-in of contaminated media from the site to the residence.

Background soil data were not collected at this site. The USGS Pluto database[4] for Cherokee County only includes a single soil sample with a lead concentration of 38 mg/kg. The mean lead concentration in soil samples collected from Cherokee County and the six surrounding counties is 30 mg/kg (Crawford, Kansas; Labette, Kansas; Jasper, Missouri; Newton, Missouri; Craig, Oklahoma; and Ottawa, Oklahoma). These data are used to define background lead concentrations for soil in the HHRA.

5.4.4 IEUBK Model Inputs

Lead risks for children trespassing or recreating along the rail lines were calculated using the IEUBK model. Table 5-1 presents the IEUBK input parameters used in this assessment. All of these parameters are USEPA defaults (USEPA 1994a,b, 2007, 2009a) except as described below.

Soil to Dust Transfer Factor (M_{SD})

Soil can be a dominant source of lead in indoor dust at residences. The IEUBK model incorporates a soil-to-dust transfer factor that can be used, in the absence of indoor dust lead concentration data, to describe the potential for lead in soil to be transported indoors and contribute to the concentration of lead in dust. This transfer factor is called the M_{SD} and it is defined as the mass fraction of soil-derived particles in indoor dust (gram soil/gram dust) (USEPA 1998b):

$$Pb_{dust} = M_{SD} \cdot Pb_{soil} + (0.1 \cdot Pb_{air})$$

where:

Pb_{dust} = Concentration of lead in indoor dust (µg Pb/g dust)
M_{SD} = Mass fraction of soil in dust (g soil/g dust)

[4]Available online at http://mrdata.usgs.gov/pluto/soil/.

Pb_{soil} = Outdoor soil lead concentration (µg Pb/g soil)
Pb_{air} = Concentration of lead in outdoor air (µg Pb/m^3 air)

The IEUBK model generally assumes that the concentration of lead in indoor dust is 0.70 (70%) of the concentration in outdoor soil plus a small contribution from outdoor air when soil is the predominant source of lead in indoor dust (i.e., there is no indoor lead-based paint). In the absence of site-specific paired soil-dust measurements, the default M_{SD} value of 0.70 was used in the risk assessment.

For the child recreational visitor, it is assumed that people who recreate at the site generally reside nearby, whereby site soil will be tracked back to the residence. The mean frequency-adjusted soil concentration was used with the default M_{SD} to derive an indoor dust lead exposure concentration that reflects track-in of contaminated media from the site to the residence. For the child recreational visitor, this may be a conservative assumption because M_{SD} is intended to represent indoor dust derived from residential yard soil. This may also be a conservative assumption for visitors who live distant to the site for the same reason and because they are distant they are less likely to track site-related contamination back to their residences.

RBA

The default value of RBA for lead in soil and dust assumed by the IEUBK model is 60%. Studies of lead RBA at a variety of mine sites suggest that this is a typical value, but values at some sites may be higher or lower (USEPA 2007). USEPA has developed a method for measuring the IVBA of lead in soil under conditions in which the IVBA and RBA are well correlated. The resultant IVBA results can then be used to estimate RBA values using the following equation (USEPA 2007):

$$RBA = 0.878 \cdot IVBA\ (fraction) - 0.028$$

As described in Section 2.6, USEPA conducted lead IVBA testing on 43 soil samples (31 surface soil samples and 12 subsurface soil samples) collected from the rail lines in 2013 and 2014. Table 5-2 presents the lead IVBA and estimated RBA values for these samples. As shown, IVBA values in surface soils varied from 23% to 96%, corresponding to RBA values of 18-82%. For locations identified as high-frequency use areas, IVBA values in surface soils varied from 23% to 86%, corresponding to RBA values of 18-73%. For locations identified as low-frequency use areas, IVBA values in surface soils varied from 39% to 96%, corresponding to RBA values of 32-82%.

Although it is known that the ballast used in the railroad beds was originally composed of chat from surrounding mine waste piles, it is unknown as to whether or not all of the rail lines are expected to have been constructed using the same lead material. Based on such uncertainty in the source material history, and high variability in RBA values (18-82%), separate RBA values were used in the lead risk calculations based on exposure areas as follows:

Exposure Point	Population	Soil	Average IVBA (Fraction)	Estimated RBA (%)
High-frequency use	Child Recreational Visitor	Surface soil	0.535	44%
Low-frequency use			0.721	61%

Based on a default absolute absorption fraction of 50% for lead in water and diet, the exposure point specific RBA values of 44% and 61% correspond to absolute bioavailability (ABA) values of 22% and 30% for evaluating lead exposures to high-frequency use child recreational visitors and low-frequency use child recreational visitors, respectively. These ABA values (22 and 30) were used as alternative inputs for both soil and dust absorption fraction percent in the IEUBK model.

5.4.5 ALM Inputs

Because the exposure frequency and duration for the site visitors and for the hypothetical future construction workers meet the minimum exposure criteria for use of the ALM, the site-specific exposure and media concentration information may be used in the ALM. Intake rates and exposure frequencies are the same as assumed for CTE non-lead exposures (see Tables 4-1, 4-2, and 4-3). Table 5-3 summarizes the ALM-specific input values selected for each scenario. All values are USEPA-recommended defaults (USEPA 2003b, 2009c) except as noted below.

Baseline Blood Lead (PbB_0) and Geometric Standard Deviation (GSDi) Value

PbB_0 and GSD_i are derived from data reported by the National Health and Nutrition Evaluation Survey (NHANES). USEPA (2009c ALM update) recommends using the data from 1999–2004 NHANES to assess non-residential exposures[5]. For the purposes of this assessment, uncertainty in this approach is described in further detail below.

[5] http://www.epa.gov/superfund/lead/almfaq.htm#nhanesupdate

RBA

As described above for the IEUBK model, site-specific surface soil data indicate average soil RBA values of 44% and 61% for the high-frequency recreational use areas and the low-frequency recreational use areas, respectively.

It is assumed that hypothetical future construction workers will be exposed to lead in both surface and subsurface soils during excavation-type activities. As shown in Table 5-2, IVBA values in subsurface soils varied from 26% to 76%, corresponding to RBA values of 20-64%.

As described above for the IEUBK model, it is unknown as to whether or not all of the rail lines are expected to have been constructed using the same lead material. Based on such uncertainty in the source material history, and high variability in RBA values (18-82%), separate RBA values were used in the lead risk calculations based on exposure areas as follows:

<table>
<tr><th>Exposure Point</th><th>Population</th><th>Soil</th><th>Average IVBA (fraction)</th><th>Estimated RBA (%)</th></tr>
<tr><td>High-frequency use</td><td rowspan="2">Adolescent/Adult Recreational Visitor</td><td rowspan="2">Surface soil</td><td>0.535</td><td>44%</td></tr>
<tr><td>Low-frequency use</td><td>0.721</td><td>61%</td></tr>
<tr><td>Site</td><td>Future Worker</td><td>Surface + subsurface soil</td><td>0.608</td><td>51%</td></tr>
</table>

Absorption Fraction (AF) Values

The ALM model identifies a default AF for lead in soil of 12%.

Adjusted ALM AF values for soil are calculated as:

$$AF(soil) = AF(water) \cdot RBA$$

In order to estimate an AF value for lead in water, it is assumed that the ratio of absorption from water compared to soil is the same as is assumed in the IEUBK model:

$$AF(water) = AF(soil) \cdot \text{IEUBK ratio (water/soil)} = 0.12 \cdot (50/30) = 0.20(20\%)$$

This can be used with the site-specific RBA information to derive site-specific adjusted ALM AF values for site exposures to soil as follows:

Exposure Point	Site RBA	Adjusted AF (soil)
High-frequency use	44%	9%
Low-frequency use	61%	12%
Site	51%	10%

An AF for lead in air of 12% will be used based on the assumption that air exposures at the site are predominantly entrained soil-dust particles (relatively large particles) that would be deposited in the upper airway and eventually move to the gastrointestinal tract and follow ingested intake (USEPA 2003b).

5.5 Results

Appendix E presents the detailed risk calculations for lead. Results are summarized below.

5.5.1 Risks to Children

Table 5-4 summarizes the probabilities of a recreational child exposed to lead in soil having a blood lead level that exceeds 10 µg/dL for each exposure point. Both P10 values are below EPA's health-based goal of 5%.

5.5.2 Risks to Adults

Table 5-5 summarizes the risk of blood lead values exceeding 10 µg/dL in the fetuses of pregnant women who may trespass or recreate along the rail lines in high-frequency use and low-frequency use areas, or who may be involved in future excavation activities. P10 values are shown for each site-related exposure pathway for each exposure scenario, and for all pathways combined for each exposure scenario. Note that the P10 values are not additive, but instead are a non-linear function of the sum of the absorbed doses from each pathway.

As indicated in the table, P10 values are below USEPA's health based guideline (P10 ≤5%) for all receptors.

5.6 Uncertainty Assessment for Lead

Quantification of risks to humans from exposures to lead is subject to a number of data limitations and uncertainties. The most important factors at the site are summarized below.

Because of these uncertainties, the P10 values reported above should be understood to be estimates. However, despite the uncertainties in the exact quantification of risk, there is little uncertainty in the main conclusions.

Uncertainty in Lead Exposure

Exposure to lead at the site occurs mainly through the ingestion pathway, with only a small additional dose being contributed by the inhalation pathway. Thus, the main source of uncertainty in lead exposure is the amount of soil ingested by recreational visitors and workers. No data are available for soil intake rates for populations of this type, and the values assumed in the calculations are based on professional judgment, using data for residential exposures as a frame of reference. However, values used in these calculations are thought to be conservative, such that this source of uncertainty is not likely to result in a significant underestimation of exposure and risk.

There is uncertainty in the assumption that inhalation exposure during future excavation work is a minor contributor relative to the ingestion pathway. In cases where the future construction activity on contaminated soil generates dust clouds, exposed workers who inhale the dust would not necessarily be protected. Additionally, there is uncertainty in the actual exposure frequency and duration for on-site recreational visitors and future construction workers. The best available information was used in the risk assessment calculations, but the results are only applicable to the exposures shown. More frequent users would not necessarily be protected.

Uncertainty in Average Lead Concentrations

The mean lead concentration in soil is used in the exposure and risk calculations. However, there is uncertainty in the true average concentration of lead in soil.

Soil samples used in this assessment were not sieved. As noted above, it is generally expected that metal enrichment occurs in the fine fraction (<250 µm) of soil particles that are more likely than coarse particles (2 mm) to adhere to the hands (or other objects that may be mouthed) and be subsequently ingested (USEPA 2000, 2007). Studies of other sites have suggested enrichment of lead concentrations in the fine fraction (Kim et al. 2011; Luo et al. 2011; Juhasz et al. 2011; Madrid et al. 2008; Pye et al. 2007; Ljung et al. 2006, 2007; Weiss et al. 2006; Momani 2006; Tawinteung et al. 2005). Lead concentrations in the bulk and fine fractions of two 2014 surface soil samples are summarized in Table 5-6. As shown in the table, lead concentrations are higher in the fine fraction than the bulk samples. Thus, EPCs calculated using data from bulk samples rather than the < 250 µm fraction) may underestimate actual exposure.

Uncertainty in Model Inputs

As discussed previously, the Federal Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) to the CDC recommends intervention for individual children and communities with blood lead levels at and above 5 µg/dL (CDC 2012). This recommendation is consistent with USEPA's position that there is no safe blood lead level in children. The CDC reference level will be re-evaluated every 4 years and is expected to drop as the national blood lead distribution trend has been to decrease over time. In light of the new CDC recommendation, the USEPA is re-evaluating the soil lead policy. However, as described above, current USEPA policy is to limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have no more than 5% probability of exceeding a blood lead level of 10 µg/dL. Because all sources of lead may not be addressed under USEPA Superfund authority, USEPA Office of Solid Waste and Emergency Response (OSWER) recommends coordination with other federal agencies, as well as state and local programs, to facilitate communication and outreach to establish comprehensive programs to reduce lead exposure.

For older children (6-16 years) recreational visitors, the ALM defaults were used. There are insufficient data to derive age-specific values for soil absorption fraction and BKSF, which may differ for these children as compared to adults.

Uncertainty in Model Predictions

Even if the amount of lead ingested at the site were known with confidence, the effect on blood lead would still be uncertain. This is because the rate and extent of blood lead absorption is a highly complex physiological process, and can only be approximated by a mathematical model. Thus, the blood lead values predicted both in children (by the IEUBK model) and in adults (by the ALM model) should be understood to be uncertain, and because of a general preference to use realistic or slightly conservative values, are more likely to be high than low.

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TABLES

Table 2-1. Summary Statistics for Main Line Surface Soil Samples

Panel A: ICP Main Line Surface Soil

Analyte	N Samples	N Detected	Detection Frequency (%)	Average Concentration[a] (mg/kg)	Standard Deviation (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	36	36	100	39	19	8.9	100	--
Lead	36	36	100	513	322	100	1,700	--
Zinc	36	36	100	5,968	2,734	1,600	12,600	--

Panel B: XRF[b] Main Line Surface Soil

Analyte	N Samples	N Detected	Detection Frequency (%)	Average Concentration[a] (mg/kg)	Standard Deviation (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	94	83	88	26	13	6.9	63	13
Lead	94	93	99	540	407	75	2,271	14
Zinc	94	94	100	6,973	3,677	260	20,467	--

[a]Non-detects evaluated at 1/2 the detection limit.

[b] For each XRF sample, an average of replicates was calculated (2-3 replicates per sample). For samples where all replicates were not detected, the average of replicates was calculated using the reported result (assumed to be the detection limit) and the sample was considered a non-detect. For XRF samples where some replicates were detected and some were not detected, ½ the reported value for non-detect replicates was used to calculate the average of replicates and the sample was considered a detect.

Table 2-2. Summary Statistics for Main Line Subsurface Soil Samples

Panel A: ICP Main Line Subsurface Soil

Analyte	N Samples	N Detected	Detection Frequency (%)	Average Concentration[a] (mg/kg)	Standard Deviation (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	56	53	95	39.55	29.27	0.63	113	0.82
Lead	56	56	100	737.94	922.52	7.3	4260	--
Zinc	56	56	100	8002.24	5961.02	13.9	22000	--

Panel B: XRF[b] Main Line Subsurface Soil

Analyte	N Samples	N Detected	Detection Frequency (%)	Average Concentration[a] (mg/kg)	Standard Deviation (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	470	234	50	22.69	100.80	8.72	2178.38	13.49
Lead	470	405	86	437	1079.04	5.72	16533.33	11.34
Zinc	470	470	100	4308.94	5388.18	12.45	30050	--

[a]Nondetects evaluated at 1/2 the detection limit

[b] For each XRF sample, an average of replicates was calculated (2-3 replicates per sample). For samples where all replicates were not detected, the average of replicates was calculated using the reported result (assumed to be the detection limit) and the sample was considered a non-detect. For XRF samples where some replicates were detected and some were not detected, ½ the reported value for non-detect replicates was used to calculate the average of replicates and the sample was considered a detect.

Table 2-3. Summary Statistics for Lateral Line Soil Samples

Panel A: ICP Lateral Soil (Surface and Subsurface Combined)

Analyte	N Samples	N Detected	Detection Frequency (%)	Concentration (mg/kg)
Cadmium	1	1	100	24
Lead	1	1	100	3,260
Zinc	1	1	100	7,170

Panel B: XRF[b] Lateral Soil (Surface and Subsurface Combined)

Analyte	N Samples	N Detected	Detection Frequency (%)	Average Concentration[a] (mg/kg)	Standard Deviation (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	49	11	22	9.3	9.5	8.7	66	13
Lead	49	47	96	345	543	10	2,161	11
Zinc	49	49	100	1,861	1,979	55	7,946	--

[a]Nondetects evaluated at 1/2 the detection limit

[b] For each XRF sample, an average of replicates was calculated (2-3 replicates per sample). For samples where all replicates were not detected, the average of replicates was calculated using the reported result (assumed to be the detection limit) and the sample was considered a non-detect. For XRF samples where some replicates were detected and some were not detected, ½ the reported value for non-detect replicates was used to calculate the average of replicates and the sample was considered a detect.

Table 4-1. Exposure Parameters for High-Frequency Recreational Visitors to the Cherokee County Rail Lines for Adults, Adolescents (6-16 years), and Children (0-6 years)

Exposure Pathway	Exposure Input Parameter	Units	CTE						RME					
			Adult	Source	Adolescent (6-16 yrs)	Source	Child (0-6 yrs)	Source	Adult	Source	Adolescent (6-16 yrs)	Source	Child	Source
General	Body Weight	kg	80	[1]	44.3	[5, j]	15	[1]	80	[1]	44.3	[5, j]	15	[1]
	Exposure frequency	days/yr	72	[3, a]	72	[3, a]	72	[3, a]	120	[3, a]	120	[3, a]	120	[3, a]
	Exposure duration	yr	9	[3, 5, b]	3	[3, l]	2	[3, l]	26	[1, 3, 5, c]	10	[3]	6	[1]
	Averaging Time, Cancer	days	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]
	Averaging Time, Noncancer	days	3,285	[2, d]	1,095	[2, d]	730	[2, d]	9,490	[2, d]	3,650	[2, d]	2,190	[2, d]
Ingestion of Soil	Ingestion rate	mg/day	50	[3, e]	50	[6, e]	100	[3, e]	100	[1, 3, f]	100	[6]	200	[1, 3, f]
	Conversion factor	kg/mg	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--
Inhalation of Particulates	Exposure time	hr/day	4	[3]	4	[3]	4	[3]	4	[3]	4	[3]	4	[3]
Dermal Exposure to Soil	Exposed Surface Area (SA)	cm^2/event	6,032	[1, 3, g]	4,520	[3, 5, k]	2,690	[1, 3, g]	6,032	[1, 3, g]	4,520	[3, 5, k]	2,690	[1, 3, g]
	Adherence Factor (AF)	mg/cm^2	0.01	[3, 4, h]	0.04	[3, 4, i]	0.04	[3, 4, m]	0.07	[1, 3, h]	0.4	[3, 4, i]	0.2	[1, 3, h]
	Dermal Absorption Fraction (ABSd)	unitless	CS	[4]	CS	[4]	CS	[4]	CS	[4]	CS	[4]	CS	[4]
	Event Frequency (EV)	events/day	1	[4]	1	[4]	1	[4]	1	[4]	1	[4]	1	[4]
	Conversion factor	kg/mg	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--

CTE = Central Tendency Exposure; RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] Professional judgment.

[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.

[5] USEPA 2011. Exposure Factors Handbook. EPA/600/R-090/052F.

[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 3 visits/week for a CTE visitor and 5 visits/week for an RME visitor.

[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).

[c] Assumes that area residents make up the majority of the recreational visitor population. Value of 26 years is based on the 90th percentile residential occupancy period presented in Table 16-108 of EFH (2011).

[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.

[e] Assumes CTE value is half of the RME value.

[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.

[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.

[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).

[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.

[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.

[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.

[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)

[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.

Table 4-2. Exposure Parameters for Low-Frequency Recreational Visitors to the Cherokee County Rail Lines for Adults, Adolescents (6-16 years), and Children (0-6 years)

Exposure Pathway	Exposure Input Parameter	Units	CTE						RME					
			Adult	Source	Adolescent (6-16 yrs)	Source	Child (0-6 yrs)	Source	Adult	Source	Adolescent (6-16 yrs)	Source	Child	Source
General	Body Weight	kg	80	[1]	44.3	[5, j]	15	[1]	80	[1]	44.3	[5, j]	15	[1]
	Exposure frequency	days/yr	24	[3, a]	24	[3, a]	24	[3, a]	72	[3, a]	72	[3, a]	72	[3, a]
	Exposure duration	yr	9	[3, 5, b]	3	[3, l]	2	[3, l]	26	[1, 3, 5, c]	10	[3]	6	[1]
	Averaging Time, Cancer	days	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]	25,550	[2, d]
	Averaging Time, Noncancer	days	3,285	[2, d]	1,095	[2, d]	730	[2, d]	9,490	[2, d]	3,650	[2, d]	2,190	[2, d]
Ingestion of Soil	Ingestion rate	mg/day	50	[3, e]	50	[6, e]	100	[3, e]	100	[1, 3, f]	100	[6]	200	[1, 3, f]
	Conversion factor	kg/mg	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--
Inhalation of Particulates	Exposure time	hr/day	4	[3]	4	[3]	4	[3]	4	[3]	4	[3]	4	[3]
Dermal Exposure to Soil	Exposed Surface Area (SA)	cm^2/event	6,032	[1, 3, g]	4,520	[3, 5, k]	2,690	[1, 3, g]	6,032	[1, 3, g]	4,520	[3, 5, k]	2,690	[1, 3, g]
	Adherence Factor (AF)	mg/cm^2	0.01	[3, 4, h]	0.04	[3, 4, i]	0.04	[3, 4, m]	0.07	[1, 3, h]	0.4	[3, 4, i]	0.2	[1, 3, h]
	Dermal Absorption Fraction (ABSd)	unitless	CS	[4]	CS	[4]	CS	[4]	CS	[4]	CS	[4]	CS	[4]
	Event Frequency (EV)	events/day	1	[4]	1	[4]	1	[4]	1	[4]	1	[4]	1	[4]
	Conversion factor	kg/mg	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--	1E-06	--

CTE = Central Tendency Exposure; RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.
[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.
[3] Professional judgment.
[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.
[5] USEPA 2011. Exposure Factors Handbook. EPA/600/R-090/052F.
[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 1 visit/week for a CTE visitor and 3 visits/week for an RME visitor.
[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).
[c] Assumes that area residents make up the majority of the recreational visitor population. Value of 26 years is based on the 90th percentile residential occupancy period presented in Table 16-108 of EFH (2011).

[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.
[e] Assumes CTE value is half of the RME value.
[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.
[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.
[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).
[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.
[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.
[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.
[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)
[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.

Table 4-3. Exposure Parameters for Construction Workers at the Cherokee County Rail Lines Site

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Value	Source	Value	Source
General	Body Weight	kg	80	[1]	80	[1]
	Exposure frequency	days/yr	219	[6]	250	[3, a]
	Exposure duration	yr	0.5	[3, b]	1	[3, b]
	Averaging Time, Cancer	days	25,550	[2, d]	25,550	[2, d]
	Averaging Time, Noncancer	days	183	[2, d]	365	[2, d]
Ingestion of Soil	Ingestion rate	mg/day	100	[6]	330	[8, c]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
Inhalation of Particulates	Exposure time	hr/day	8	[3, e]	8	[3, e]
Dermal Exposure to Soil	Exposed Surface Area (SA)	cm^2/event	3,470	[1, f]	3,470	[1, f]
	Adherence Factor (AF)	mg/cm^2	0.1	[4, g]	0.3	[4, g]
	Dermal Absorption Fraction (ABSd)	unitless	CS	[4]	CS	[4]
	Event Frequency (EV)	events/day	1	[4]	1	[4]
	Conversion factor	kg/mg	1E-06	--	1E-06	--

CTE = Central Tendency Exposure; RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and

[3] Professional judgment.

[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.

[5] USEPA 2011. Exposure Factors Handbook. EPA/600/R-090/052F.

[6] USEPA 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead. Final. EPA-540-R-03-001. January.

[7] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[8] USEPA 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.

Notes:

[a] Assumes exposure frequency of 5 days/week for a RME receptor.

[b] Assumes construction/excavation project of 6 month (CTE) or 1 year (RME) duration.

[c] Exhibit 5-1. Default value for construction scenario (330 mg/day) is based on the 95th percentile value for adult soil intake rates reported in a soil ingestion mass-balance study.

[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.

[e] Assumes the entire workday is outdoors.

[f] Assumes that the exposed surface area is equal to the USEPA default for a worker.

[g] Exhibit 3-3. 95th percentile value (0.3) assumed for the RME receptor and the geometric mean value (0.1) assumed for the CTE receptor.

Table 4-4. Summary of HIF and TWF Values

Panel A: Human Intake Factors (HIFs)

Exposure Unit	Receptor	Exposure Medium	Exposure Route	Units	HIF			
					Non-Cancer		Cancer	
					CTE	RME	CTE	RME
High-Frequency Recreational Use Areas	Child Visitor (0-6 years)	Surface Soil	Ingestion	kg/kg-day	1.32E-06	4.38E-06	3.76E-08	3.76E-07
			Dermal	kg/kg-day	1.42E-06	1.18E-05	4.04E-08	1.01E-06
	Adolescent Visitor (6-16 years)	Surface Soil	Ingestion	kg/kg-day	2.23E-07	7.42E-07	9.54E-09	1.06E-07
			Dermal	kg/kg-day	8.05E-07	1.34E-05	3.45E-08	1.92E-06
	Adult Visitor	Surface Soil	Ingestion	kg/kg-day	1.23E-07	4.11E-07	1.59E-08	1.53E-07
			Dermal	kg/kg-day	1.49E-07	1.74E-06	1.91E-08	6.45E-07
Low-Frequency Recreational Use Areas	Child Visitor (0-6 years)	Surface Soil	Ingestion	kg/kg-day	4.38E-07	2.63E-06	1.25E-08	2.25E-07
			Dermal	kg/kg-day	4.72E-07	7.08E-06	1.35E-08	6.06E-07
	Adolescent Visitor (6-16 years)	Surface Soil	Ingestion	kg/kg-day	7.42E-08	4.45E-07	3.18E-09	6.36E-08
			Dermal	kg/kg-day	2.68E-07	8.05E-06	1.15E-08	1.15E-06
	Adult Visitor	Surface Soil	Ingestion	kg/kg-day	4.11E-08	2.47E-07	5.28E-09	9.16E-08
			Dermal	kg/kg-day	1.49E-07	1.04E-06	6.37E-09	3.87E-07
Site	Construction Worker	Surface + Subsurface Soil	Ingestion	kg/kg-day	7.50E-07	2.83E-06	5.36E-09	4.04E-08
			Dermal	kg/kg-day	2.60E-06	8.91E-06	1.86E-08	1.27E-07

Panel B: Time-Weighting Factors (TWFs)

Exposure Unit	Receptor	Exposure Medium	Exposure Route	Units	TWF			
					Non-Cancer		Cancer	
					CTE	RME	CTE	RME
High-Frequency Recreational Use Areas	Child Visitor (0-6 years)	Surface Soil	Inhalation of Particulates	Unitless	3.29E-02	5.48E-02	9.39E-04	4.70E-03
	Adolescent Visitor (6-16 years)	Surface Soil	Inhalation of Particulates	Unitless	3.29E-02	5.48E-02	1.41E-03	7.83E-03
	Adult Visitor	Surface Soil	Inhalation of Particulates	Unitless	3.29E-02	5.48E-02	4.23E-03	2.04E-02
Low-Frequency Recreational Use Areas	Child Visitor (0-6 years)	Surface Soil	Inhalation of Particulates	Unitless	1.10E-02	3.29E-02	3.13E-04	2.82E-03
	Adolescent Visitor (6-16 years)	Surface Soil	Inhalation of Particulates	Unitless	1.10E-02	3.29E-02	4.70E-04	4.70E-03
	Adult Visitor	Surface Soil	Inhalation of Particulates	Unitless	1.10E-02	3.29E-02	1.41E-03	1.22E-02
Site	Construction Worker	Surface + Subsurface Soil	Inhalation of Particulates	Unitless	2.00E-01	2.28E-01	1.43E-03	3.26E-03

Table 4-5. Oral and Dermal Human Health Toxicity Values for Non-Lead COPCs

Analyte	CAS No.	Oral				Note	Dermal				Primary Target Organ (noncancer effects)	Weight of Evidence (Cancer)
		RfD (mg/kg-day)	Source	CSF $(mg/kg\text{-}day)^{-1}$	Source		Absorption Fraction	Adjust?	RfD_{ABS} (mg/kg-day) [2]	CSF_{ABS} $(mg/kg\text{-}day)^{-1}$		
Cadmium	7440-43-9	1.0E-03	I			[1]	0.025	Yes	2.5E-05		kidney	
Zinc	7440-66-6	3.0E-01	I				1	No	3.0E-01		blood	

Source: USEPA (January 2015)

Key: I = IRIS

Notes:

[1] IRIS presents an oral "water" RfD for use in assessment of risks to water and an oral "food" RfD for use in assessment of risks to soil and biota.

[2] Absorbed Reference Doses for Dermal were derived using the Oral Reference Dose as follows: $RFD_{ABS} = RfD_o * ABS_{GI}$ (Equation 4.3 from USEPA 2004)

Table 4-6. Inhalation Human Health Toxicity Values for Non-Lead COPCs

Analyte	CAS No.	Inhalation				Primary Target Organ (noncancer effects)	Weight of Evidence (Cancer)
		RfC (mg/m^3)	Source	UR $(ug/m^3)^{-1}$	Source		
Cadmium	7440-43-9	1.0E-05	A	1.8E-03	I	kidney/lung	Likely to be carcinogenic to humans
Zinc	7440-66-6					blood	

Source: USEPA (January 2015)

Key: I = IRIS; A = ATSDR

Table 4-7. Summary of Estimated Hazards and Risks to Non-Lead COPCs

Exposed Population	Receptor	Exposure Medium	Exposure Route	Non-cancer HI			Excess cancer Risk		
				CTE	RME	Risk Drivers	CTE	RME	Risk Drivers
Child	High-frequency Recreational Visitor	Surface Soil	Incidental Ingestion	9E-02	3E-01				
			Dermal Contact	3E-03	2E-02				
			Inhalation of Particulates	1E-04	2E-04		6E-11	3E-10	
		Medium Total		9E-02	3E-01		6E-11	3E-10	
	Low-frequency Recreational Visitor	Surface Soil	Incidental Ingestion	3E-02	2E-01				
			Dermal Contact	9E-04	1E-02				
			Inhalation of Particulates	4E-05	1E-04		2E-11	2E-10	
		Medium Total		3E-02	2E-01		2E-11	2E-10	
Adolescent	High-frequency Recreational Visitor	Surface Soil	Incidental Ingestion	1E-02	5E-02				
			Dermal Contact	1E-03	2E-02				
			Inhalation of Particulates	1E-04	2E-04		9E-11	5E-10	
		Medium Total		2E-02	8E-02		9E-11	5E-10	
	Low-frequency Recreational Visitor	Surface Soil	Incidental Ingestion	5E-03	3E-02				
			Dermal Contact	5E-04	1E-02				
			Inhalation of Particulates	4E-05	1E-04		3E-11	3E-10	
		Medium Total		6E-03	5E-02		3E-11	3E-10	
Adult	High-frequency Recreational Visitor	Surface Soil	Incidental Ingestion	8E-03	3E-02				
			Dermal Contact	3E-04	3E-03				
			Inhalation of Particulates	1E-04	2E-04		3E-10	1E-09	
		Medium Total		9E-03	3E-02		3E-10	1E-09	
	Low-frequency Recreational Visitor	Surface Soil	Incidental Ingestion	3E-03	2E-02				
			Dermal Contact	9E-05	2E-03				
			Inhalation of Particulates	4E-05	1E-04		9E-11	8E-10	
		Medium Total		3E-03	2E-02		9E-11	8E-10	
	Construction Worker	Surface and Subsurface Soil	Incidental Ingestion	5E-02	2E-01				
			Dermal Contact	5E-03	2E-02				
			Inhalation of Particulates	3E-01	3E-01		4E-08	8E-08	
		Medium Total		3E-01	5E-01		4E-08	8E-08	

Table 4-8. Bulk vs. Fine Concentration Data for Non-Lead COPCs

Location	Analyte	Bulk Result (mg/kg)	Fine Result (mg/kg)	Ratio Fine:Bulk
14	Cadmium	23.9	50	2.1
14	Zinc	4,230	8,630	2.0
13-B	Cadmium	43.3	74.4	1.7
13-B	Zinc	7,500	12,800	1.7

Table 5-1 IEUBK Model Inputs

CONSTANT MODEL INPUTS

PARAMETER	VALUE	BASIS
Soil concentration (mg/kg)	Decision Unit-specific weighted soil concentration	Time weighted soil lead concentration for each DU
Dust concentration (mg/kg)*	$C_{dust} = 0.7 \bullet C_{soil(weighted)} + 0.1(\text{air conc})$	Derived from residential soil lead concentration IEUBK Default (EPA 1994)
Air concentration (µg/m^3)	0.10	IEUBK Default (EPA 1994)
Indoor air concentration (µg/m^3)	30% of outdoors	IEUBK Default (EPA 1994)
Drinking water concentration (µg/L)	4.0	IEUBK Default (EPA 1994)
Absorption Fractions:		
Air	32%	IEUBK Default (EPA 1994)
Diet	50%	IEUBK Default (EPA 1994)
Water	50%	IEUBK Default (EPA 1994)
Soil/Dust		
High-Frequency Recreational Use	22%	Site-specific
Low-Frequency Recreational Use	30%	Site-specific
RBA (soil)		Site-specific: See Table 5-2
High-Frequency Recreational Use	44%	
Low-Frequency Recreational Use	61%	
Fraction soil	45%	IEUBK Default (EPA 1994)
GSD	1.6	IEUBK Default (EPA 1994)

*Assuming that site soil will be tracked back to the residence by recreational visitors.

AGE DEPENDENT MODEL INPUTS

	AIR		DIET	WATER	SOIL
Age	Time Outdoors (hrs)	Ventilation Rate (m^3/day)	Dietary Intake [1] (µg/day)	Intake (L/day)	Intake (mg/day)
0-1	1.0	2.0	2.26	0.20	85
1-2	2.0	3.0	1.96	0.50	135
2-3	3.0	5.0	2.13	0.52	135
3-4	4.0	5.0	2.04	0.53	135
4-5	4.0	5.0	1.95	0.55	100
5-6	4.0	7.0	2.05	0.58	90
6-7	4.0	7.0	2.22	0.59	85

[1] Revised USEPA (2009) recommended dietary intake parameters, based on updated dietary lead intake estimates from the Food and Drug Administration Total Diet Study (FDA 2006) and food consumption data from NHANES III (CDC 1997).

Table 5-2. In vitro Bioaccessibility and Estimated Relative Bioavailability of Lead in Rail Line Soil Samples Collected in 2013 & 2014

Sample Year	Location	Exposure Area	Depth	Total Lead (mg/kg)	In Vitro Bioaccessible Fraction	Estimated Relative Bioavailability	Estimated Absolute Bioavailability
2013	CCR-SS-25B	HFR	0-6	1860	0.564	47%	23%
	CCR-SS-11A	LFR	0-6	2330	0.700	59%	29%
	CCR-SS-12B	LFR	0-6	1690	0.551	46%	23%
	CCR-SS-1A	LFR	0-6	1640	0.639	53%	27%
	CCR-SS-26A	LFR	0-6	3240	0.643	54%	27%
	CCR-SS-13A	HFR	6-12	1990	0.460	38%	19%
	CCR-SS-24B	HFR	6-12	1860	0.450	37%	18%
	CCR-SS-28A	LFR	6-12	1800	0.483	40%	20%
	CCR-SS-33A	LFR	6-12	2280	0.521	43%	21%
	CCR-SS-6A	LFR	6-12	964	0.752	63%	32%
	CCR-SS-27B	LFR	12-18	2070	0.549	45%	23%
	CCR-SS-31B	LFR	12-18	1970	0.470	38%	19%
	CCR-SS-13E	HFR	18-24	518	0.263	20%	10%
	CCR-SS-26B	LFR	18-24	1680	0.498	41%	20%
	CCR-SS-29B	LFR	18-24	1150	0.516	43%	21%
	CCR-SS-32A	LFR	18-24	2690	0.663	55%	28%
	CCR-SS-1C	LFR	24-30	637	0.764	64%	32%
2014	17A	HFR	0-6	856	0.518	43%	21%
	17B	HFR	0-6	1025	0.768	65%	32%
	17C	HFR	0-6	1833	0.863	73%	36%
	13-Baxter Springs A	HFR	0-6	2631	0.559	46%	23%
	13-Baxter Springs B	HFR	0-6	2552	0.695	58%	29%
	13-Baxter Springs C	HFR	0-6	2187	0.604	50%	25%
	25A	HFR	0-6	1028	0.597	50%	25%
	25B	HFR	0-6	1035	0.407	33%	16%
	24A	HFR	0-6	1280	0.397	32%	16%
	24B	HFR	0-6	1994	0.486	40%	20%
	15A	HFR	0-6	184	0.233	18%	9%
	15B	HFR	0-6	372	0.267	21%	10%
	14A	HFR	0-6	246	0.537	44%	22%
	32A	LFR	0-6	1553	0.690	58%	29%
	32B	LFR	0-6	1876	0.913	77%	39%
	32C	LFR	0-6	1917	0.745	63%	31%
	8C	LFR	0-6	844	0.921	78%	39%
	8B	LFR	0-6	917	0.961	82%	41%
	8A	LFR	0-6	788	0.944	80%	40%
	1A	LFR	0-6	1256	0.729	61%	31%
	1B	LFR	0-6	841	0.609	51%	25%
	1C	LFR	0-6	707	0.588	49%	24%
	26A	LFR	0-6	1515	0.759	64%	32%
	26B	LFR	0-6	1460	0.814	69%	34%
	13-Lawton A	LFR	0-6	223	0.391	32%	16%
	13-Lawton B	LFR	0-6	167	0.665	56%	28%

HFR = high-frequency recreational; LFR = low frequency recreational.

SURFACE ONLY (0-6")		Average Pb (mg/kg)	Average IVBA (fraction)	Average RBA	Average ABA
	High-Frequency Use	1,363	0.535	44%	22%
	Low-Frequency Use	1,351	0.721	61%	30%
	Site	1,356	0.637	53%	27%

ACROSS ALL DEPTHS		Average Pb (mg/kg)	Average IVBA (fraction)	Average RBA	Average ABA
	High-Frequency Use	1,379	0.510	42%	21%
	Low-Frequency Use	1,469	0.672	56%	28%
	Site	1,434	0.608	51%	25%

Table 5-3. Adult Lead Model Inputs

Exposure Point	Parameter	Value	Units	Source	Notes
General	EF(HFR)	72	days/year	Prof. judgement	Assumes 3 site visits per week for 24 consecutive weeks
	EF(LFR)	24	days/year	Prof. judgement	Assumes 1 site visit per week for 24 consecutive weeks
	EF(Worker)	219	days/year	EPA (2003)	ALM default parameter
	Averaging Time	168	days/year	Prof. judgement	7 days/week for 24 weeks
	Breathing Rate	0.63	m^3/hr	EFH (2011)	Average recommended breathing rate of 15 m^3/day for an adult age 6-36 years
	PbB0	1.0	ug/dL	EPA (2009)	EPA recommended default
	GSD	1.8	--	EPA (2009)	EPA recommended default
	BKSF	0.4	ug/dL per ug/day	EPA (2003)	ALM default parameter
	AF(soil)	12%	--	EPA (2003)	ALM default parameter
	AF(water)	20%	--	Prof. judgement	Assumes same ratio of AF(water) to AF(soil) as IEUBK
	AF(air)	12%	--	EPA (2003)	EPA recommended default for entrained soil-dust particles
High-Frequency Use Recreational	RBA	44%	--	Site data	See Table 5-2
	AF(soil) Adj	9%	--	Calculated	AF(soil) Adj = AF(water) * RBA
Low-Frequency Use Recreational	RBA	61%	--	Site data	See Table 5-2
	AF(soil) Adj	12%	--	Calculated	AF(soil) Adj = AF(water) * RBA
Site	RBA	51%	--	Site data	See Table 5-2
	AF(soil) Adj	10%	--	Calculated	AF(soil) Adj = AF(water) * RBA

Table 5-4. IEUBK Results

Exposure Area	Average Lead Concentration[a] (mg/kg)	EF_{Pb} (days)	ED_{Pb} (days)	$PbC_{residence}$ (mg/kg)	PbC_{WTD} (mg/kg)	ABA (%)	P10 (%)
High Frequency - Surface Soil	603	72	168	30	276	22	0.291
Low Frequency - Surface Soil	520	24	168	30	100	30	0.013

[a]Nondetects analyzed at 1/2 the detection limit

Table 5-5. Lead Risk to the Adult Receptors

GSDi and PbBo Source	Population	Age	Exposure Scenarios	P10 (%)		
				Soil	Air	All
NHANES 1999-2004	High Frequency Rec Visitor	Adolescent/ Adult	[1]	<0.1%	<0.1%	<0.1%
	Low Frequency Rec Visitor	Adolescent/ Adult	[1]	<0.1%	<0.1%	<0.1%
	Construction Worker	Adult	[1]	0.4%	<0.1%	0.4%

[1] Exposed via incidental ingestion of soil and inhalation of soil particulates.

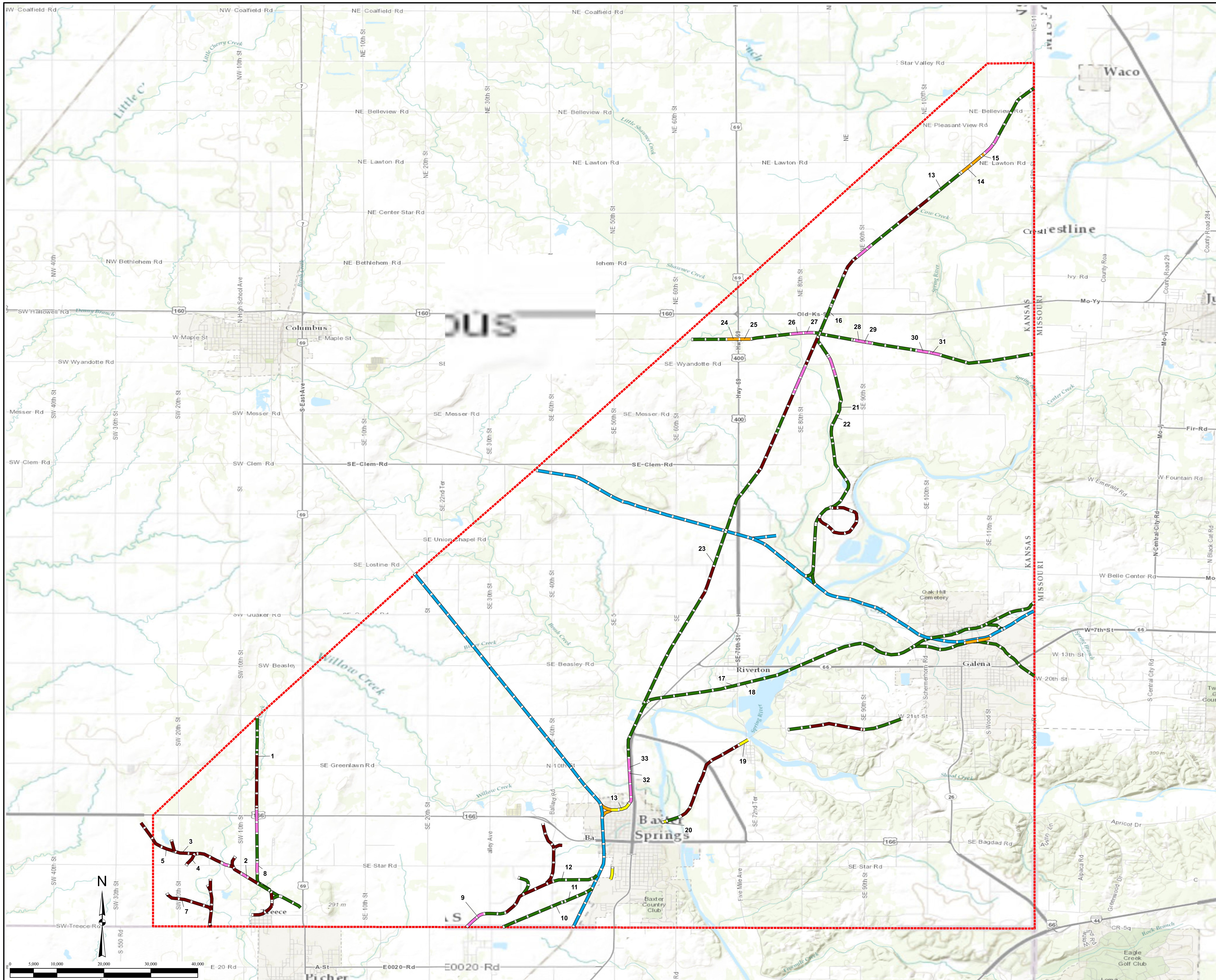
Table 5-6. Bulk vs. Fine Concentration Data for Lead

Location	Analyte	Bulk Result (mg/kg)	Fine Result (mg/kg)	Ratio Fine:Bulk
14	Lead	101	290	2.9
13-B	Lead	1,080	3,880	3.6

FIGURES

Figure 2-1

Rail Line Sampling Locations



Legend

Rail Classification

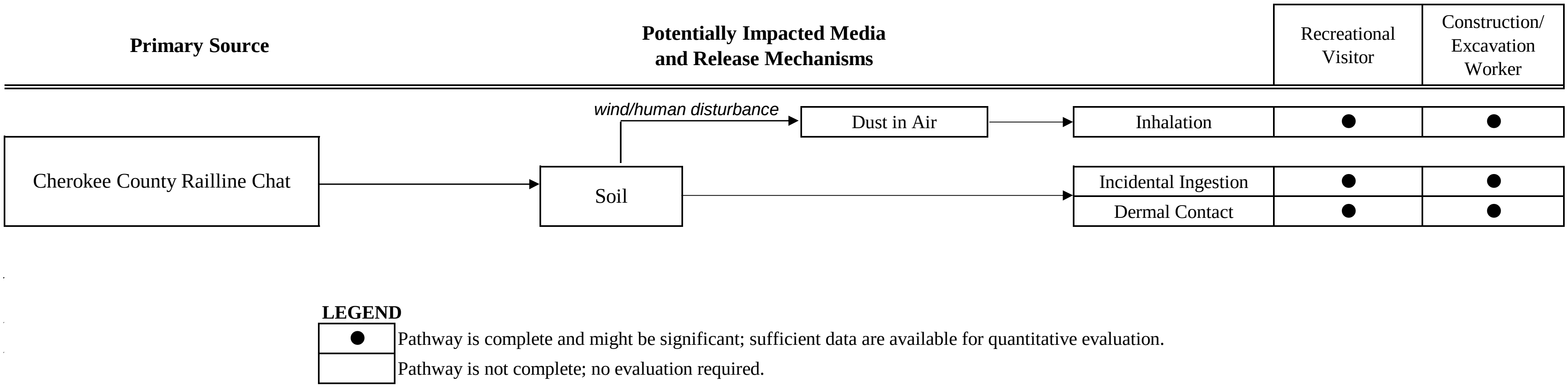
- Active Line
- Confirmed Class 1, Residential
- Confirmed Class 1, Rural
- Suspected Class 1, Rural
- Suspected Class 2, Rural
- Suspected Class 2, Residential
- Site Boundary
- 10 Sample Location

Notes:
Class 1=Rail line is beginning to deteriorate; no evidence of ties or they are broken down, some weathering of rail bed (visible rail bed topography exists at the site)
Class 2=Rail line is deteriorated; rail bed is discontinuous or has been weathered extensively
Rural=land is agricultural or wooded with little or no exposure
Residential=land is in residential areas

\\Gst-srv-01\HGLGIS\Cherokee_County\Site_RR\(4-1)Prop_Frm_RR_Class.mxd
1/28/2014 JG
Source: HGL, ESRI Online USA Topo Map

HGL
HydroGeoLogic, Inc

Figure 3-1. Conceptual Site Model for Human Exposure at the Cherokee County Railines (OU8) Site



APPENDIX A

RAW DATA
[ELECTRONIC FILE – APPENDIX A.XLSX]

THIS SLIPSHEET IS FOR SDMS PURPOSES ONLY

The Excel files for this document cannot be uploaded into SDMS. The document on CD is available in the site file.

APPENDIX B

ANALYSIS OF XRF SOIL DATA QUALITY

1.0 Overview

Main line soil sampling was conducted at the Cherokee County Rail Lines Operable Unit 8 (OU8) site in 2013 and 2014. All soil samples were analyzed for cadmium, lead and zinc by X-ray Fluorescence Spectroscopy (XRF). Approximately 12% of the soil samples collected in 2013 and all of the soil samples collected in 2014 were also analyzed by Inductively Coupled Plasma Spectroscopy (ICP). In order to determine if XRF soil data are reliable for use in the risk assessment, a data quality assessment of the data was conducted as described in this Appendix.

2.0 Methods for Evaluating Data Quality

Two methods were used to evaluate the quality of the XRF data: (1) evaluation of XRF detection limits, and (2) analysis of correlation between XRF concentrations and the corresponding (paired) ICP concentrations.

Detection Limit Evaluation

The detection limit was evaluated by examining the XRF detection frequency and also by comparing the estimated XRF detection limits to screening levels for risk assessment. In order for a detection limit to be deemed adequate, either (1) the detection frequency had to be high (>80%) such that concentrations in soil were adequately characterized or (2) if the detection frequency was not high (<80%), then the estimated XRF detection limit had to be less than the lowest soil risk-based screening level (SL).

XRF results reported as "<" a number were considered non-detects. For such qualified values, the reported XRF screening concentration was assumed to represent the detection limit for that sample.

Correlation with ICP Concentrations

The XRF data were also evaluated by comparing detected XRF concentrations to their corresponding (paired) ICP values, if also detected. This was done by plotting XRF concentrations (x-axis) versus ICP concentrations (y-axis) and fitting a straight regression line through the data. Only pairs where both the XRF and ICP results were above the detection limit were used in the regression analyses (data that were qualified as non-detects were excluded). A minimum of 10 pairs of ICP/XRF data were required to perform a regression analysis. The R^2

value was used to determine if the XRF correlation with ICP concentration was adequate. If the R^2 value was less than 0.7, it was concluded that the accuracy of the XRF method for analysis of that chemical was unacceptably low compared to ICP. The value of 0.7 is based on professional judgment and is in accordance with the Standard Operating Procedure (SOP) EPA SW-846, Method 6200 *Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment*. The value of 0.7 is thought to be a reasonable level of accuracy for two analytical methods, each of which has measurement error of 20-25%. As indicated in the SOP Method 6200, if the measured concentrations span more than one order of magnitude, the data were log-transformed to standardize variance, which is proportional to the magnitude of measurement.

Overall Data Adequacy for Risk Assessment

The results from each of the evaluations described above were used to draw a conclusion on the overall adequacy of XRF data for use in risk assessment. In order for an XRF data set to be judged reliable for use in the risk assessment, both the detection limit and the correlation with ICP results must be adequate.

Data Usability for Risk Assessment

In some cases, XRF data may be less accurate than ICP data. Thus, whenever ICP data are available at a sampling location, these data are preferred over XRF data from the same location. If only XRF data are available for a sampling location, then the XRF results will be used if the data are determined adequate for use in a risk assessment. XRF data are used by adjusting the concentration data to estimate ICP-equivalent concentrations, using the chemical-specific parameters from the ICP/XRFlinear regressions as:

$$[\text{ICP-equivalent concentration}] = a + b \cdot [\text{XRF concentration}]$$

where:

a = intercept from the ICP/XRF regression line for chemical "i'
b = slope from the ICP/XRF regression line for chemical "i"

In some cases where the intercept "a" is negative, the above equation can result in negative estimates of ICP-equivalent concentrations at the low end of the XRF concentration range. In these cases, a sensitivity analysis is conducted to evaluate the following alternative strategies:

1. Force the intercept to be zero.
2. Assign a surrogate value in cases where the estimated ICP-equivalent concentration is negative.
3. Fit the data after exclusion of values well above the level of concern.

3.0 Results

A total of 94 surface soil samples and 470 subsurface soil samples were screened for cadmium, lead and zinc by XRF. Of these, 36 surface soil samples and 56 subsurface soil samples were also analyzed for cadmium, lead, and zinc by ICP. Results for these analyses are shown in Tables B-1 to B-4.

Detection Limit Evaluation

Detection frequencies for XRF data are summarized in Table B-5. As shown, detection frequencies for lead and zinc are adequate (>80%) based on both surface soil and surface + subsurface soil data. The detection frequency for cadmium in surface soil is also considered adequate. However, the detection frequency for cadmium in surface+subsurface soil is less than 80%.

The average XRF detection limit for cadmium in surface+subsurface soils was 13 mg/kg; the maximum detection limit was 44 mg/kg. These detection limits exceed a conservative screening level for cadmium of 12 mg/kg that is calculated assuming a recreational visitor exposure for 214 days (April-October) at a target hazard quotient (THQ) of 0.1. On this basis, the XRF detection limit for cadmium based on surface + subsurface soil is not adequate for use in risk assessment.

Correlation with ICP Concentrations

For surface soil, 36 paired XRF/ICP results are available each for cadmium, lead and zinc. For surface + subsurface soil, 92 paired XRF/ICP results are available for each analyte. Figures B-1 to B-6 plot the correlations based on the paired XRF/ICP data. As shown in Table B-6, minimum criterion for considering XRF data adequate for use in the risk assessment of R^2 at least 0.7 based on log-transformation of the data was met for lead and zinc, but not cadmium.

Data Adequacy and Usability

Table B-7 summarizes the general findings of the data adequacy evaluation. As seen in the table, XRF data for lead and zinc are considered adequate for use in the risk assessment based on meeting both data quality evaluations as outlined above. The XRF results for cadmium did not meet the criteria and are not considered reliable for risk assessment.

With regard to data usability, the XRF data for lead in surface soil and zinc in surface soil and surface+subsurface soil can be used to calculated ICP-equivalent concentrations using the regression equations presented in Table B-8. However, the ICP/XRF linear regression line for lead in surface+subsurface soils has a slope of 1.275 and an intercept of -90.37. Thus, any XRF results less than around 70 ppm will result in a negative ICP-equivalent concentration. This occurs for 202 lead XRF results for which there is no paired lab sample. Table B-9 provides the results of a sensitivity analysis performed as described above. As shown, the strategy of forcing the intercept through zero results in the most conservative assumption of a mean lead concentration for the surface+subsurface dataset. This approach of assuming that the true intercept is zero is considered to be statistically acceptable because the 95% confidence interval around the intercept term includes zero.

3.1 Summary

In conclusion, XRF data for lead and zinc are considered adequate for use in the risk assessment; XRF data for cadmium are not considered adequate for use in the risk assessment (see Table B-7).

TABLES

Table B-1. XRF Summary Statistics for the Main Rail Line Surface Soil Data

Analyte	N Samples	N Detects	Detection Frequency (%)	Average Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	94	83	88	26	63	13
Lead	94	93	99	540	2,271	14
Zinc	94	94	100	6,973	20,467	--

Table B-2. ICP Summary Statistics for the Main Rail Line Surface Soil Data

Analyte	N Samples	N Detects	Detection Frequency (%)	Average Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	36	36	100	39	100	--
Lead	36	36	100	513	1,700	--
Zinc	36	36	100	5,968	12,600	--

Table B-3. XRF Summary Statistics for the Main Rail Line Subsurface Soil Data

Analyte	N Samples	N Detects[a]	Detection Frequency (%)[a]	Average Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	470	234	50	23	2,178	13
Lead	470	405	86	437	16,533	11
Zinc	470	470	100	4,309	30,050	--

Table B-4. ICP Summary Statistics for the Main Rail Line Subsurface Soil Data

Analyte	N Samples	N Detects	Detection Frequency (%)	Average Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Detection Limit (mg/kg)
Cadmium	56	53	95	40	113	0.82
Lead	56	56	100	738	4,260	--
Zinc	56	56	100	8,002	22,000	--

Table B-5. XRF Data Quality Summary for 2013 Residential Soil Data

Analyte	Surface Soil		Surface + Subsurface Soil	
	N Samples	Detection Frequency (%)	N Samples	Detection Frequency (%)
Cadmium	94	88	564	56
Lead	94	99	564	88
Zinc	94	100	564	100

Table B-6. ICP/XRF Correlations

Analyte	Surface Soil (N=36 ICP/XRF Pairs)			Surface + Subsurface Soil (N=92 ICP/XRF Pairs)		
	Untransformed R^2	Log-Transformed R^2	Correlation Adequate?[b]	Untransformed R^2	Log-Transformed R^2	Correlation Adequate?[b]
Cadmium	0.316	0.423	No	0.410	0.380	No
Lead	0.806	0.863	Yes	0.689	0.827	Yes
Zinc	0.555	0.732	Yes	0.541	0.853	Yes

[a]Number of paired detected ICP/XRF concentrations.

[b]Correlation is adequate if $R^2 \geq 0.7$.

Table B-7. XRF Data Quality Summary

Analyte	Surface Soil			Surface + Subsurface Soil		
	Detection Limit Adequate?	Correlation Adequate?	Data Set Reliable?	Detection Limit Adequate?	Correlation Adequate?	Data Set Reliable?
Cadmium	Yes	No	No	No	No	No
Lead	Yes	Yes	Yes	Yes	Yes	Yes
Zinc	Yes	Yes	Yes	Yes	Yes	Yes

Table B-8. Estimation of ICP-Equivalent Concentrations from XRF Data

Equation:

[ICP-equivalent concentration] = a + b · [XRF concentration]

Parameters:

Dataset	Analyte	Intercept (a)	Slope (b)
Surface Soil	Lead	75.37	0.847
	Zinc	1,654	0.595
Surface + Subsurface Soil	Lead	-90.38	1.275
	Zinc	1,079	0.87

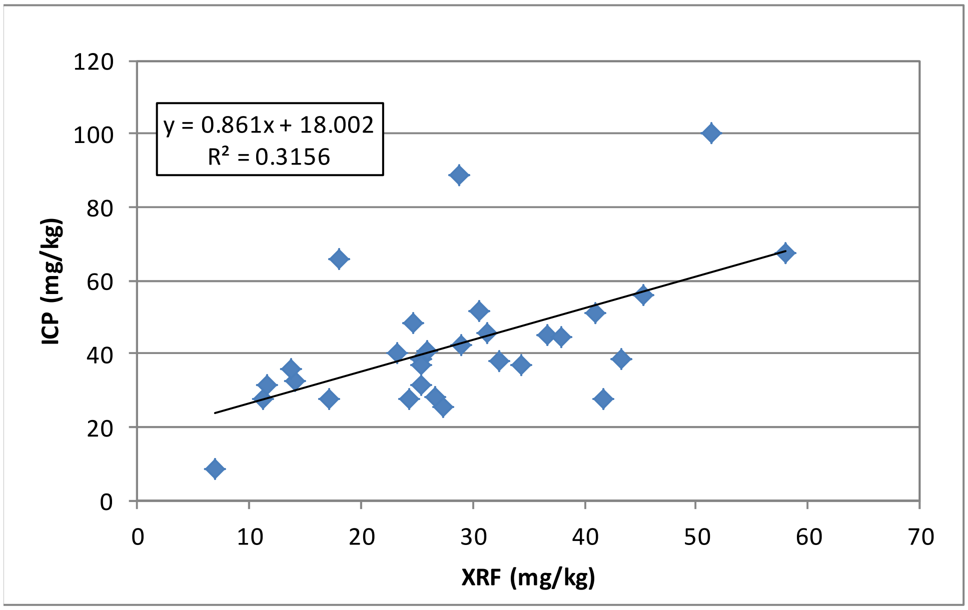
Table B-8. Sensitivity Analysis for Lead in Surface + Subsurface Soil

Approach	Regression	Mean Lead Concentration (mg/kg)
Set the intercept equal to zero	y = 1.184x	537
Use a surrogate value equal to the average reporting limit	y = 1.2753x – 90.383	525
Fit a separate regression line excluding high concentrations (*>1,200 mg/kg*)	Pb<1,200 mg/kg: y = 0.8395x + 63.153 Pb≥1,200 mg/kg: y = 1.2753x – 90.383	530

FIGURES

Figure B-1. ICP/XRF Correlation Based on Cadmium in Surface Soils

Panel A: Linear



Panel B: Log-Transformed

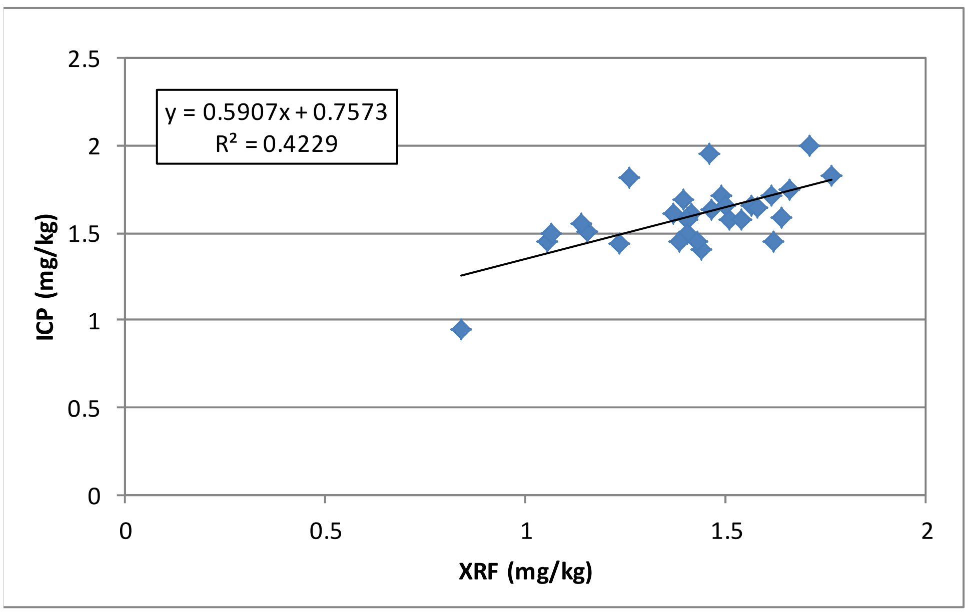
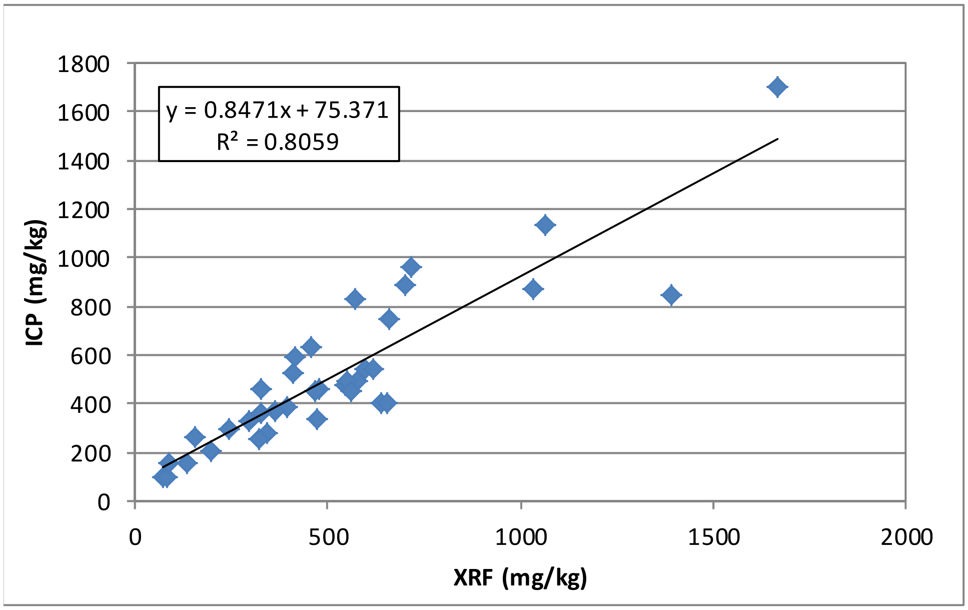


Figure B-2. ICP/XRF Correlation Based on Lead in Surface Soil

Panel A: Linear



Panel B: Log-Transformed

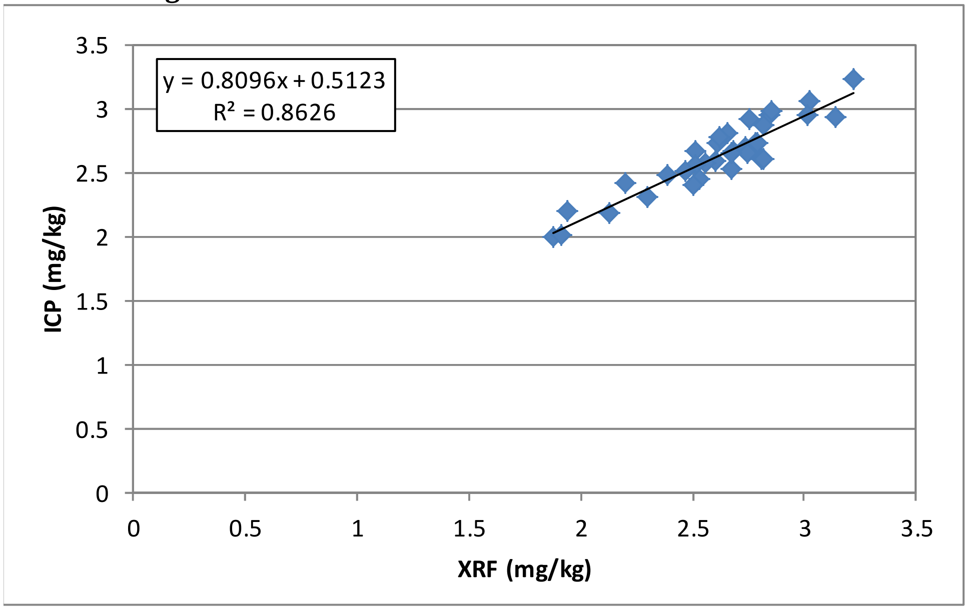
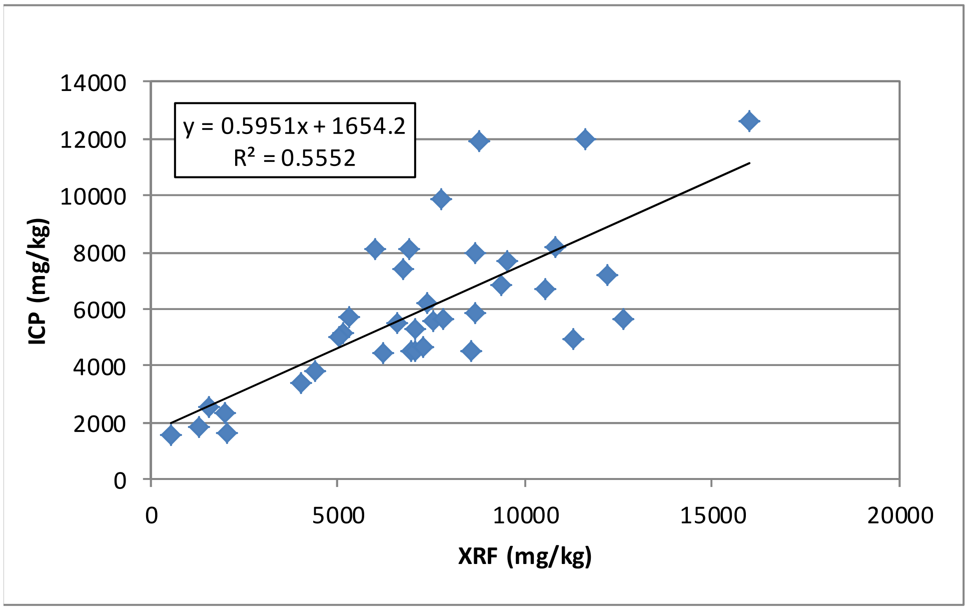


Figure B-3. ICP/XRF Correlation Based on Zinc in Surface Soil

Panel A: Linear



Panel B: Log-Transformed

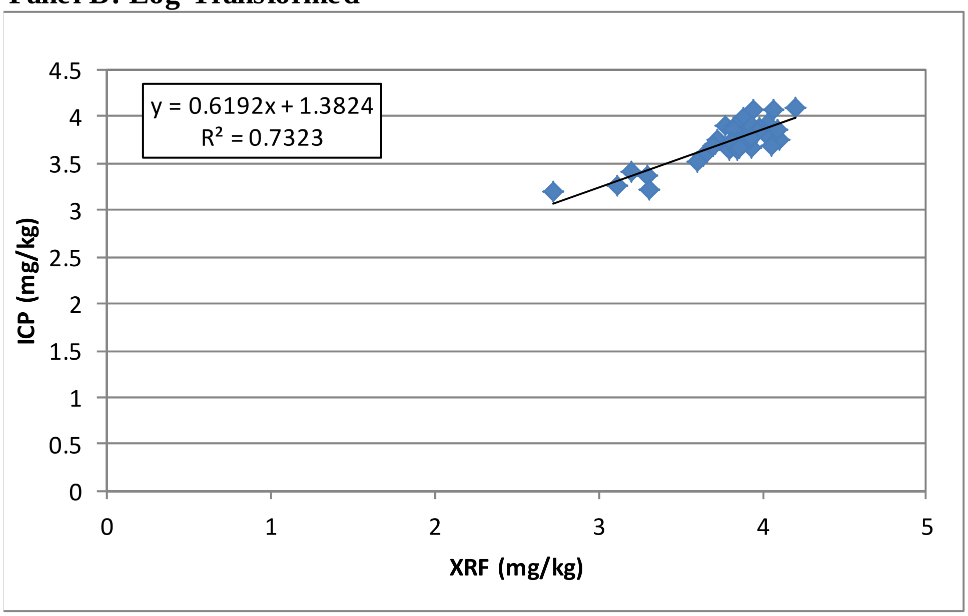
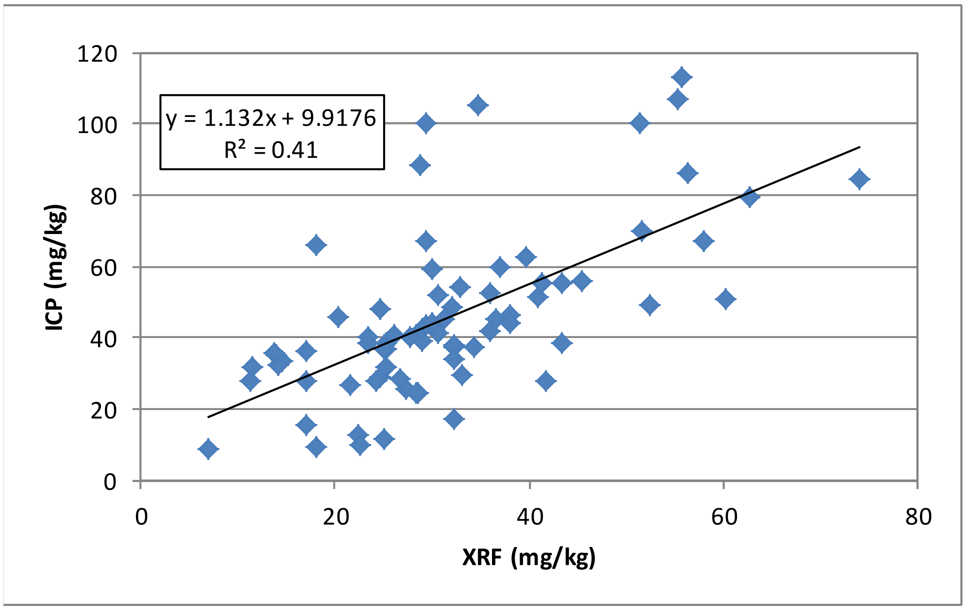


Figure B-4. ICP/XRF Correlation Based on Cadmium in Surface+Subsurface Soil

Panel A: Linear



Panel B: Log-Transformed

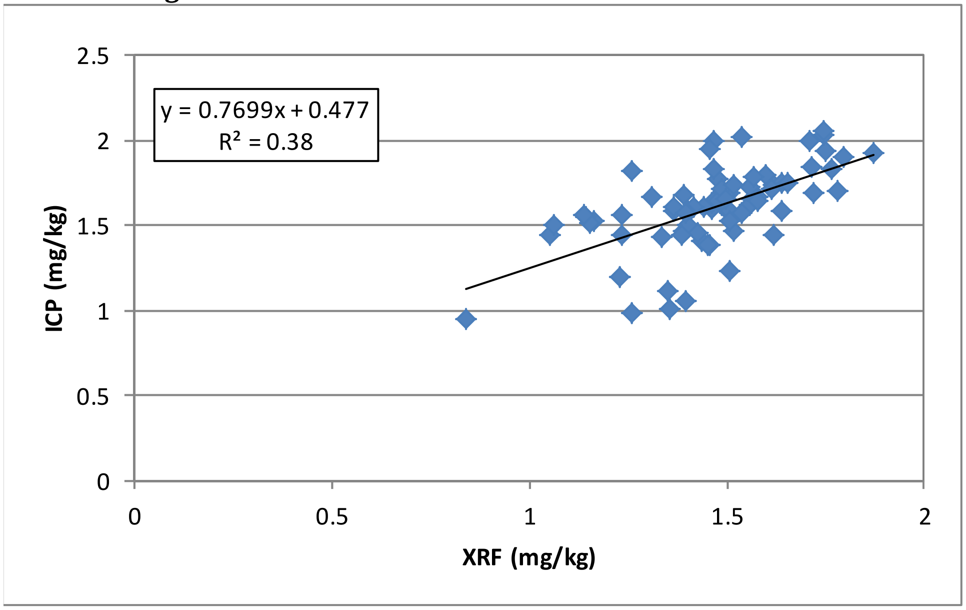
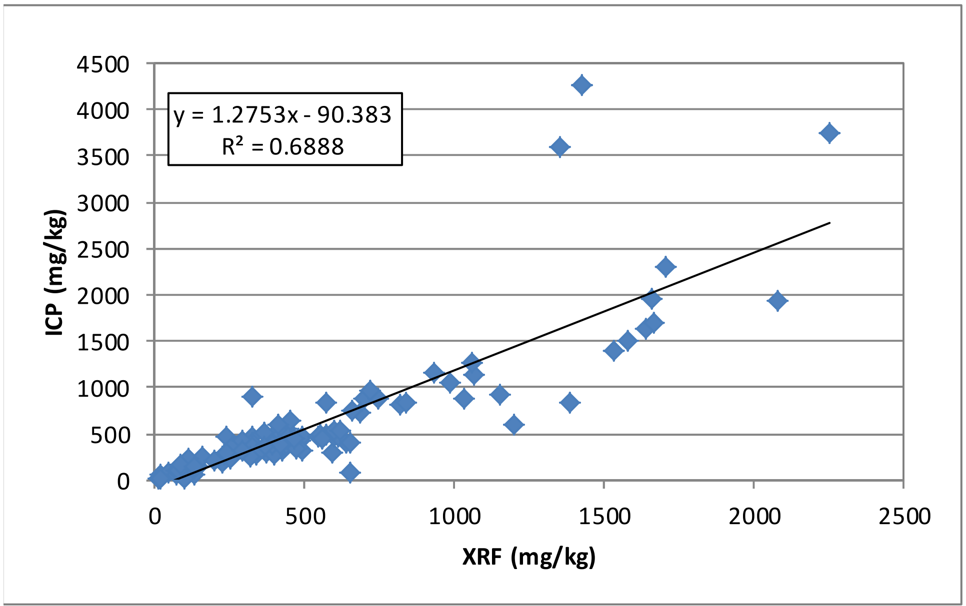


Figure B-5. ICP/XRF Correlation Based on Lead in Surface + Subsurface Soil

Panel A: Linear



Panel B: Log-Transformed

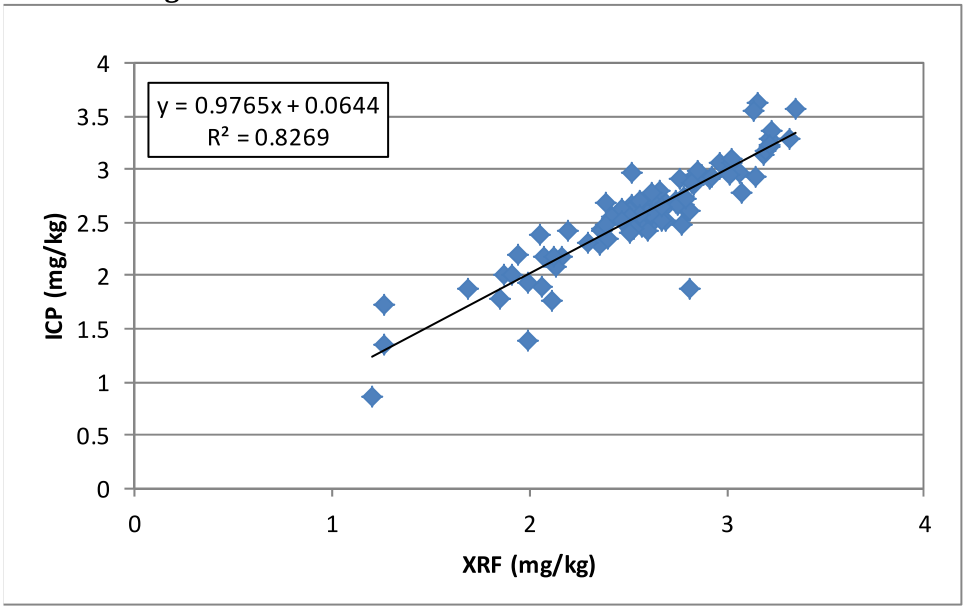
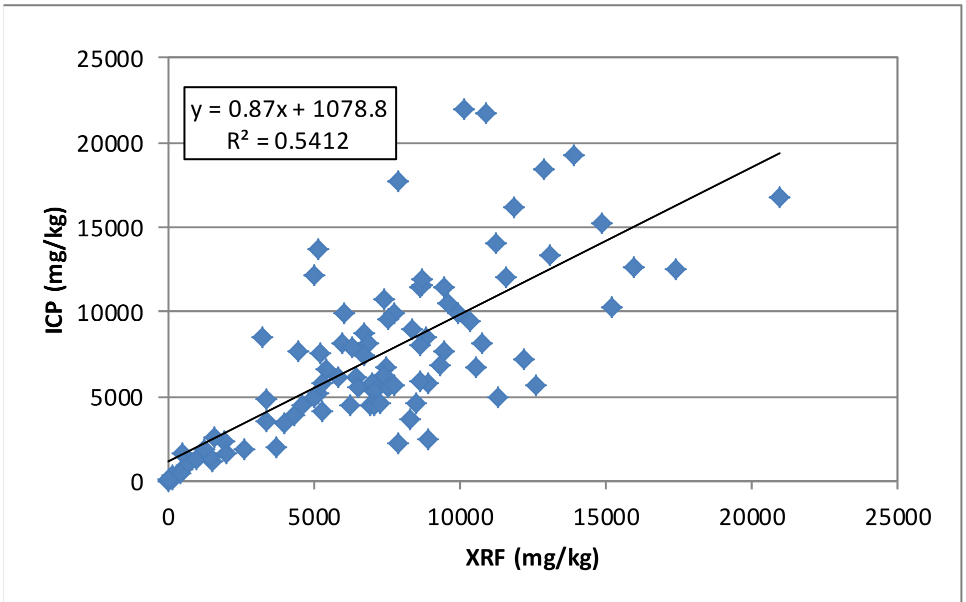
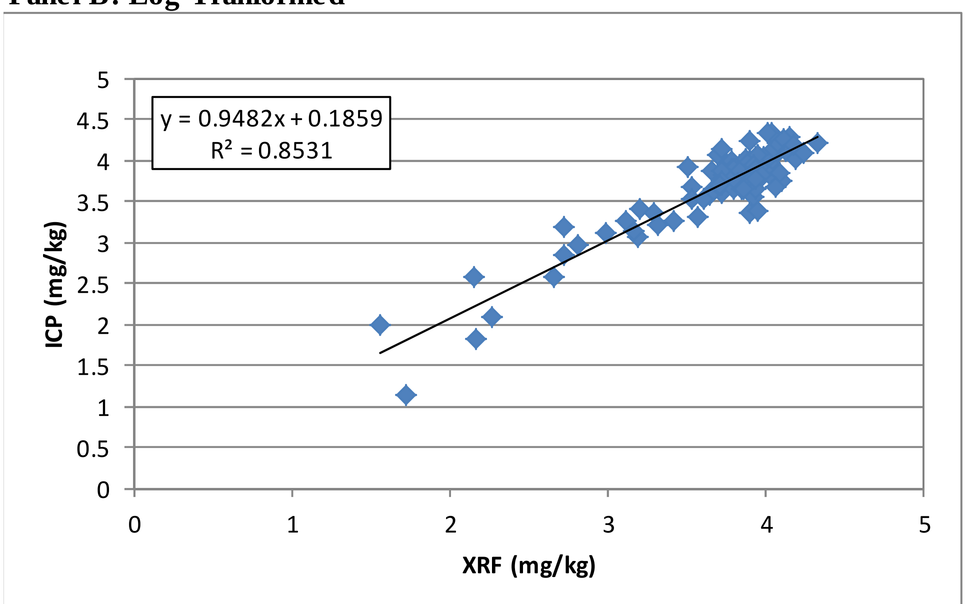


Figure B-6. ICP/XRF Correlation Based on Zinc in Surface + Subsurface Soil

Panel A: Linear



Panel B: Log-Tranformed



APPENDIX C

ProUCL OUTPUT

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	4/7/2015 16:33
From File	CCR_UCLinput_v2.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

CdSSHigh

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	11.4	Mean	37.07
Maximum	88.7	Median	37.1
SD	20.64	Std. Error of Mean	5.33
Coefficient of Variation	0.557	Skewness	1.113

Normal GOF Test

Shapiro Wilk Test Statistic	0.92	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.164	Lilliefors GOF Test
5% Lilliefors Critical Value	0.229	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	46.46	95% Adjusted-CLT UCL (Chen-1995)	47.48
		95% Modified-t UCL (Johnson-1978)	46.72

Gamma GOF Test

A-D Test Statistic	0.188	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.105	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.223	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.538	k star (bias corrected MLE)	2.875
Theta hat (MLE)	10.48	Theta star (bias corrected MLE)	12.9
nu hat (MLE)	106.1	nu star (bias corrected)	86.25
MLE Mean (bias corrected)	37.07	MLE Sd (bias corrected)	21.86
		Approximate Chi Square Value (0.05)	65.84
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	63.65

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	48.56	95% Adjusted Gamma UCL (use when n<50)	50.24

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.966	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.134	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.229	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.434	Mean of logged Data	3.465
Maximum of Logged Data	4.485	SD of logged Data	0.581

Assuming Lognormal Distribution

95% H-UCL	52.95	90% Chebyshev (MVUE) UCL	54.87
95% Chebyshev (MVUE) UCL	62.79	97.5% Chebyshev (MVUE) UCL	73.79
99% Chebyshev (MVUE) UCL	95.38		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	45.84	95% Jackknife UCL	46.46
95% Standard Bootstrap UCL	45.58	95% Bootstrap-t UCL	48.92
95% Hall's Bootstrap UCL	52.79	95% Percentile Bootstrap UCL	46.13
95% BCA Bootstrap UCL	46.97		
90% Chebyshev(Mean, Sd) UCL	53.06	95% Chebyshev(Mean, Sd) UCL	60.31
97.5% Chebyshev(Mean, Sd) UCL	70.36	99% Chebyshev(Mean, Sd) UCL	90.11

Suggested UCL to Use

95% Student's-t UCL	46.46

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

CdSSLow

General Statistics

Total Number of Observations	21	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	8.9	Mean	39.69
Maximum	100	Median	37.2
SD	19.07	Std. Error of Mean	4.162
Coefficient of Variation	0.481	Skewness	1.564

Normal GOF Test

Shapiro Wilk Test Statistic	0.88	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.908	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.15	Lilliefors GOF Test
5% Lilliefors Critical Value	0.193	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	46.86	95% Adjusted-CLT UCL (Chen-1995)	48.05
		95% Modified-t UCL (Johnson-1978)	47.1

Gamma GOF Test

A-D Test Statistic	0.416	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.155	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.19	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.828	k star (bias corrected MLE)	4.17
Theta hat (MLE)	8.22	Theta star (bias corrected MLE)	9.517
nu hat (MLE)	202.8	nu star (bias corrected)	175.1
MLE Mean (bias corrected)	39.69	MLE Sd (bias corrected)	19.43
		Approximate Chi Square Value (0.05)	145.5
Adjusted Level of Significance	0.0383	Adjusted Chi Square Value	143.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	47.76	95% Adjusted Gamma UCL (use when n<50)	48.45

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.908	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.179	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.193	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.186	Mean of logged Data	3.574
Maximum of Logged Data	4.605	SD of logged Data	0.494

Assuming Lognormal Distribution

95% H-UCL	50.17	90% Chebyshev (MVUE) UCL	53.47
95% Chebyshev (MVUE) UCL	59.55	97.5% Chebyshev (MVUE) UCL	68
99% Chebyshev (MVUE) UCL	84.59		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	46.53	95% Jackknife UCL	46.86
95% Standard Bootstrap UCL	46.51	95% Bootstrap-t UCL	48.76
95% Hall's Bootstrap UCL	55.04	95% Percentile Bootstrap UCL	46.75
95% BCA Bootstrap UCL	47.77		
90% Chebyshev(Mean, Sd) UCL	52.17	95% Chebyshev(Mean, Sd) UCL	57.83
97.5% Chebyshev(Mean, Sd) UCL	65.68	99% Chebyshev(Mean, Sd) UCL	81.1

Suggested UCL to Use

95% Student's-t UCL	46.86

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

CdSSSB

General Statistics

Total Number of Observations	92	Number of Distinct Observations	88
Number of Detects	89	Number of Non-Detects	3
Number of Distinct Detects	85	Number of Distinct Non-Detects	3
Minimum Detect	0.63	Minimum Non-Detect	0.215
Maximum Detect	113	Maximum Non-Detect	0.75
Variance Detects	633.9	Percent Non-Detects	3.26%
Mean Detects	40.49	SD Detects	25.18
Median Detects	37.9	CV Detects	0.622
Skewness Detects	0.888	Kurtosis Detects	0.783
Mean of Logged Detects	3.428	SD of Logged Detects	0.905

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.926	Normal GOF Test on Detected Observations Only
5% Shapiro Wilk P Value	3.64E-05	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.102	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0939	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	39.18	Standard Error of Mean	2.688
SD	25.64	95% KM (BCA) UCL	43.67
95% KM (t) UCL	43.64	95% KM (Percentile Bootstrap) UCL	43.79
95% KM (z) UCL	43.6	95% KM Bootstrap t UCL	43.9
90% KM Chebyshev UCL	47.24	95% KM Chebyshev UCL	50.89
97.5% KM Chebyshev UCL	55.96	99% KM Chebyshev UCL	65.92

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.334	Anderson-Darling GOF Test
5% A-D Critical Value	0.765	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.119	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.096	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.981	k star (bias corrected MLE)	1.921
Theta hat (MLE)	20.44	Theta star (bias corrected MLE)	21.07
nu hat (MLE)	352.6	nu star (bias corrected)	342
MLE Mean (bias corrected)	40.49	MLE Sd (bias corrected)	29.21

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.335	nu hat (KM)	429.6
Approximate Chi Square Value (429.58, α)	382.5	Adjusted Chi Square Value (429.58, β)	381.8
95% Gamma Approximate KM-UCL (use when n>=50)	43.99	95% Gamma Adjusted KM-UCL (use when n<50)	44.07

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.63	Mean	39.36
Maximum	113	Median	37.45
SD	25.52	CV	0.648
k hat (MLE)	1.82	k star (bias corrected MLE)	1.768
Theta hat (MLE)	21.63	Theta star (bias corrected MLE)	22.26
nu hat (MLE)	334.8	nu star (bias corrected)	325.2
MLE Mean (bias corrected)	39.36	MLE Sd (bias corrected)	29.6
		Adjusted Level of Significance (β)	0.0474
Approximate Chi Square Value (325.25, α)	284.5	Adjusted Chi Square Value (325.25, β)	283.9
95% Gamma Approximate UCL (use when n>=50)	45	95% Gamma Adjusted UCL (use when n<50)	45.09

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.175	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.0939	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	39.31	Mean in Log Scale	3.363
SD in Original Scale	25.59	SD in Log Scale	0.958
95% t UCL (assumes normality of ROS data)	43.74	95% Percentile Bootstrap UCL	43.7
95% BCA Bootstrap UCL	43.73	95% Bootstrap t UCL	43.88
95% H-UCL (Log ROS)	57.01		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	39.17	Mean in Log Scale	3.259
SD in Original Scale	25.78	SD in Log Scale	1.286
95% t UCL (Assumes normality)	43.64	95% H-Stat UCL	83.86

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	43.67

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ZnSSHigh

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	1660	Mean	5334
Maximum	9435	Median	5221
SD	2250	Std. Error of Mean	530.3
Coefficient of Variation	0.422	Skewness	0.0388

Normal GOF Test

Shapiro Wilk Test Statistic	0.965	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.106	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6257	95% Adjusted-CLT UCL (Chen-1995)	6212
		95% Modified-t UCL (Johnson-1978)	6258
Gamma GOF Test			
A-D Test Statistic	0.396	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.139	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.204	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	4.953	k star (bias corrected MLE)	4.164
Theta hat (MLE)	1077	Theta star (bias corrected MLE)	1281
nu hat (MLE)	178.3	nu star (bias corrected)	149.9
MLE Mean (bias corrected)	5334	MLE Sd (bias corrected)	2614
		Approximate Chi Square Value (0.05)	122.6
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	120.2
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	6522	95% Adjusted Gamma UCL (use when n<50)	6650
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.915	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.164	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	7.415	Mean of logged Data	8.478
Maximum of Logged Data	9.152	SD of logged Data	0.503
Assuming Lognormal Distribution			
95% H-UCL	6984	90% Chebyshev (MVUE) UCL	7406
95% Chebyshev (MVUE) UCL	8310	97.5% Chebyshev (MVUE) UCL	9563
99% Chebyshev (MVUE) UCL	12025		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	6207	95% Jackknife UCL	6257
95% Standard Bootstrap UCL	6183	95% Bootstrap-t UCL	6244
95% Hall's Bootstrap UCL	6238	95% Percentile Bootstrap UCL	6187
95% BCA Bootstrap UCL	6214		
90% Chebyshev(Mean, Sd) UCL	6925	95% Chebyshev(Mean, Sd) UCL	7646
97.5% Chebyshev(Mean, Sd) UCL	8646	99% Chebyshev(Mean, Sd) UCL	10611
Suggested UCL to Use			
95% Student's-t UCL	6257		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ZnSSLow

General Statistics			
Total Number of Observations	57	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	1600	Mean	6036
Maximum	13834	Median	5495
SD	2686	Std. Error of Mean	355.8
Coefficient of Variation	0.445	Skewness	0.983

Normal GOF Test

Shapiro Wilk Test Statistic	0.923	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	0.00129	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.163	Lilliefors GOF Test
5% Lilliefors Critical Value	0.117	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6631	95% Adjusted-CLT UCL (Chen-1995)	6671
		95% Modified-t UCL (Johnson-1978)	6639

Gamma GOF Test

A-D Test Statistic	0.536	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.105	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.118	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.263	k star (bias corrected MLE)	4.997
Theta hat (MLE)	1147	Theta star (bias corrected MLE)	1208
nu hat (MLE)	599.9	nu star (bias corrected)	569.7
MLE Mean (bias corrected)	6036	MLE Sd (bias corrected)	2700
		Approximate Chi Square Value (0.05)	515.3
Adjusted Level of Significance	0.0458	Adjusted Chi Square Value	514

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	6673	95% Adjusted Gamma UCL (use when n<50)	6690

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.964	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	0.177	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.107	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.117	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.378	Mean of logged Data	8.608
Maximum of Logged Data	9.535	SD of logged Data	0.46

Assuming Lognormal Distribution

95% H-UCL	6822	90% Chebyshev (MVUE) UCL	7228
95% Chebyshev (MVUE) UCL	7753	97.5% Chebyshev (MVUE) UCL	8481
99% Chebyshev (MVUE) UCL	9911		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6622	95% Jackknife UCL	6631
95% Standard Bootstrap UCL	6625	95% Bootstrap-t UCL	6742
95% Hall's Bootstrap UCL	6718	95% Percentile Bootstrap UCL	6624
95% BCA Bootstrap UCL	6676		
90% Chebyshev(Mean, Sd) UCL	7104	95% Chebyshev(Mean, Sd) UCL	7587
97.5% Chebyshev(Mean, Sd) UCL	8258	99% Chebyshev(Mean, Sd) UCL	9576

Suggested UCL to Use

95% Approximate Gamma UCL	6673

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ZnSSSB

General Statistics

Total Number of Observations	545	Number of Distinct Observations	531
		Number of Missing Observations	0
Minimum	13.9	Mean	5159
Maximum	27222	Median	3154
SD	4804	Std. Error of Mean	205.8
Coefficient of Variation	0.931	Skewness	1.368

Normal GOF Test

Shapiro Wilk Test Statistic	0.817	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.184	Lilliefors GOF Test
5% Lilliefors Critical Value	0.038	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5499	95% Adjusted-CLT UCL (Chen-1995)	5511
		95% Modified-t UCL (Johnson-1978)	5501

Gamma GOF Test

A-D Test Statistic	16.18	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.778	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.0403	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.263	k star (bias corrected MLE)	1.257
Theta hat (MLE)	4086	Theta star (bias corrected MLE)	4105
nu hat (MLE)	1376	nu star (bias corrected)	1370
MLE Mean (bias corrected)	5159	MLE Sd (bias corrected)	4602
		Approximate Chi Square Value (0.05)	1285
Adjusted Level of Significance	0.0496	Adjusted Chi Square Value	1285

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5501	95% Adjusted Gamma UCL (use when n<50)	5501

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.916	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.118	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.038	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.632	Mean of logged Data	8.103
Maximum of Logged Data	10.21	SD of logged Data	0.997

Assuming Lognormal Distribution

95% H-UCL	5946	90% Chebyshev (MVUE) UCL	6273
95% Chebyshev (MVUE) UCL	6656	97.5% Chebyshev (MVUE) UCL	7189
99% Chebyshev (MVUE) UCL	8236		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	5498	95% Jackknife UCL	5499
95% Standard Bootstrap UCL	5506	95% Bootstrap-t UCL	5508
95% Hall's Bootstrap UCL	5507	95% Percentile Bootstrap UCL	5500
95% BCA Bootstrap UCL	5521		
90% Chebyshev(Mean, Sd) UCL	5777	95% Chebyshev(Mean, Sd) UCL	6056
97.5% Chebyshev(Mean, Sd) UCL	6445	99% Chebyshev(Mean, Sd) UCL	7207

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	6056

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

APPENDIX D

DERIVATION OF PARTICULATE EMISSION FACTORS (PEF)

1.0 INTRODUCTION

People may be exposed to contaminants in soil is by inhalation of soil particles that become re-suspended in air. At most sites, however, there are no reliable site-specific measurements of airborne particulates and associated contaminant levels in air. In such cases, the concentration of contaminants may be estimated as follows (USEPA 2002):

$$C_{air} = C_{soil} / PEF$$

where:

C(air) = concentration of contaminant in air (mg/m^3)
C(soil) = concentration of contaminant in soil (mg/kg)
PEF = particulate emission factor (m^3 of air per kg of soil)

The PEF represents an estimate of the relationship between chemical concentrations in soil and the chemical concentrations in air as a consequence of particulate suspension. Estimating a PEF for construction workers depends on a number of site-specific factors, as well as the nature of the force (wind, mechanical disturbance) that leads to soil particle re-suspension in air. For construction workers, fugitive dusts may be generated by wind erosion, vehicle traffic, and other construction/excavation activities. Under a recreational visitor scenario, it is expected that fugitive dusts may be generated from surface soils by wind erosion and people disturbing the surface soil while hiking along the rail lines. The following sections present the derivation of the PEF values used to estimate contaminant concentrations in air from the re-suspension of soil attributable to wind erosion (PEFwe) and construction-related activities (PEFcw).

2.0 DERIVATION OF THE PEF FOR WIND EROSION (PEFwe)

The basic equation used to calculate the PEF for particulates suspended in air from wind erosion is (USEPA 2002):

$$PEFwe = \frac{Q}{C} \cdot \frac{3{,}600 s/h}{0.036 \cdot (1-V) \cdot \left(\frac{Um}{Ut}\right)^3 \cdot F(x)}$$

where:

PEFwe	=	Particulate Emission Factor for wind erosion (m^3/kg)
Q/C	=	Inverse of the ratio of the geometric mean air concentration to the emission flux at the center of a square source (g/m^2-s per kg/m^3)

V	=	Fraction of vegetative cover (unitless); default assumes 50%
Um	=	Mean annual windspeed (m/s); default assumes 4.69 m/s
Ut	=	Equivalent threshold value of windspeed at 7 m (m/s); default assumes 11.32 m/s
F(x)	=	Function dependent on Um/Ut derived using Cowherd et al. (1985) (unitless); default assumes 0.194

The default PEF presented in USEPA (2002) that accounts for windborne dust emissions is 1.36×10^9 m^3/kg. This value is used to evaluate inhalation exposures of recreational visitors.

3.0 DERIVATION OF THE PEF FOR EXCAVATION ACTIVITIES (PEFcw)

For a construction worker scenario, traffic on unpaved roads typically accounts for the majority of dust emissions, with wind erosion, excavation, soil dumping, dozing, grading, and tilling operations contributing lesser emissions (USEPA 2002). The basic equation used to calculate the PEF for particulates suspended in air as a result of truck traffic on exposed soils is (USEPA 2002, 2014):

$$PEFcw = \frac{Q}{C_{sr}} \cdot \frac{1}{F_D} \cdot \frac{T(s) \cdot A_R(m^2)}{\frac{2.6 \cdot (\frac{s}{12})^{0.8} \cdot (\frac{W(tons)}{3})^{0.4}}{\frac{Mdry}{0.2}^{0.3}} \cdot \frac{365\left(\frac{e}{y}\right) \cdot p\left(\frac{d}{y}\right)}{365\frac{d}{y}} \cdot 281.9 \cdot \sum VKT\ (km)}$$

where:

PEFcw	=	Particulate Emission Factor for road traffic (m^3/kg)
Q/Csr	=	Inverse of the ratio of the 1-h geometric mean air concentration to the emission flux along a straight road segment bisecting a square site (g/m^2-s per kg/m^3)
F_D	=	Dispersion correction factor (unitless)
T	=	Total time over which construction occurs (s)
A_R	=	Surface area of contaminated road segment (m^2), $A_R = L_R \times W_R \times 0.92903$ m^2/ft^2

L_R	=	Length of road segment (ft); square root of site surface contamination configured as a square
W_R	=	Width of road segment (ft), default = 20 ft

s	=	Road surface silt content (%), default = 8.5%
W	=	Mean vehicle weight (tons)
M_{dry}	=	Road surface material moisture content under dry, uncontrolled conditions (%), default = 0.2%
p	=	Number of days per year with at least 0.01 inches of precipitation
∑VKT	=	Sum of fleet vehicle kilometers traveled during the exposure duration (km)

This equation requires estimates of parameters such as the number of days with at least 0.01 inches of rainfall (p) and mean vehicle weight (W). For this assessment, the number of days with at least 0.01 inches of rainfall was estimated at 100 days based on USEPA (2002, Exhibit 5-2). Mean vehicle weight estimated assuming 5 cars weighing an average of 2 tons each and 5 trucks weighing an average of 20 tons, where the mean vehicle weight is:

$$W = [(5 \text{ cars} \cdot 2 \text{ tons/car}) + (5 \text{ trucks} \cdot 20 \text{ tons/truck})]/10 \text{ vehicles} = 11 \text{ tons}$$

The numbers of cars and trucks is based on professional judgment and the weights of cars and trucks is based on the example presented in USEPA (2002, 2014).

The USEPA Regional Screening Level Calculator[1] was used to calculate the PEFcw value using the above assumptions to calculate a site-specific PEFcw of 3.2E+06 m^3/kg.

3.0 REFERENCES

Cowherd, C.G., Muleski, G., Engelhart, P., and Gillette, D. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites. U.S. EPA, Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-85/002.

U.S. EPA 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December 2002. http://www.epa.gov/superfund/health/conmedia/soil/index.htm

U.S. EPA. 2014. Regional Screening Level Tables User's Guide (November 2014). http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

[1] Available online at http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.

APPENDIX E

DETAILED NON-LEAD RISK CALCULATIONS

Population Adult High Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Incidental Ingestion

HIFs	CTE	RME
Noncancer	1.23E-07	4.11E-07
Cancer	1.59E-08	1.53E-07

			Non-Cancer					Cancer				
	EPC	RBA	DI (mg/kg-d)		RfD	HQ		DI (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.6E+01	1.00	5.7E-06	1.9E-05	1.0E-03	6E-03	2E-02					
Zinc	6.3E+03	1.00	7.7E-04	2.6E-03	3.0E-01	3E-03	9E-03					
Total						8E-03	3E-02					

Population Adult High Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Dermal Contact

HIFs	CTE	RME
Noncancer	1.49E-07	1.74E-06
Cancer	1.91E-08	6.45E-07

			Non-Cancer					Cancer				
	EPC	ABSd	DAD (mg/kg-d)		RfD	HQ		DAD (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.6E+01	0.001	6.9E-09	8.1E-08	2.5E-05	3E-04	3E-03					
Zinc	6.3E+03	NV										
Total						3E-04	3E-03					

Population Adult High Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Inhalation of Particulates

TWFs	CTE	RME
Noncancer	3.29E-02	5.48E-02
Cancer	4.23E-03	2.04E-02

	Csoil		Non-Cancer					Cancer				
	EPC	PEF	EC (mg/m3)		RfC	HQ		EC (ug/m3)		iUR	Risk	
COPC	mg/kg	m^3/kg	CTE	RME	mg/m^3	CTE	RME	CTE	RME	$(ug/m^3)^{-1}$	CTE	RME
Cadmium	4.6E+01	1.36E+09	1.1E-09	1.9E-09	1.0E-05	1E-04	2E-04	1.4E-07	7.0E-07	1.8E-03	3E-10	1E-09
Zinc	6.3E+03											
Total						1E-04	2E-04				3E-10	1E-09

APPENDIX E. NON-LEAD RISK CALCULATIONS

Population	Adolescent High Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Incidental Ingestion

HIFs	CTE	RME
Noncancer	2.23E-07	7.42E-07
Cancer	9.54E-09	1.06E-07

			Non-Cancer					Cancer				
	EPC	RBA	DI (mg/kg-d)		RfD	HQ		DI (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.6E+01	1.00	1.0E-05	3.4E-05	1.0E-03	1E-02	3E-02					
Zinc	6.3E+03	1.00	1.4E-03	4.6E-03	3.0E-01	5E-03	2E-02					
Total						1E-02	5E-02					

Population	Adolescent High Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Dermal Contact

HIFs	CTE	RME
Noncancer	8.05E-07	1.34E-05
Cancer	3.45E-08	1.92E-06

			Non-Cancer					Cancer				
	EPC	ABSd	DAD (mg/kg-d)		RfD	HQ		DAD (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.6E+01	0.001	3.7E-08	6.2E-07	2.5E-05	1E-03	2E-02					
Zinc	6.3E+03	NV										
Total						1E-03	2E-02					

Population	Adolescent High Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Inhalation of Particulates

TWFs	CTE	RME
Noncancer	3.29E-02	5.48E-02
Cancer	1.41E-03	7.83E-03

	Csoil		Non-Cancer					Cancer				
	EPC	PEF	EC (mg/m3)		RfC	HQ		EC (ug/m3)		iUR	Risk	
COPC	mg/kg	m^3/kg	CTE	RME	mg/m^3	CTE	RME	CTE	RME	(ug/m^3)$^{-1}$	CTE	RME
Cadmium	4.6E+01	1.36E+09	1.1E-09	1.9E-09	1.0E-05	1E-04	2E-04	4.8E-08	2.7E-07	1.8E-03	9E-11	5E-10
Zinc	6.3E+03											
Total						1E-04	2E-04				9E-11	5E-10

APPENDIX E. NON-LEAD RISK CALCULATIONS

Population Child High Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Incidental Ingestion

HIFs	CTE	RME
Noncancer	1.32E-06	4.38E-06
Cancer	3.76E-08	3.76E-07

			Non-Cancer					Cancer				
	EPC	RBA	DI (mg/kg-d)		RfD	HQ		DI (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.6E+01	1.00	6.1E-05	2.0E-04	1.0E-03	6E-02	2E-01					
Zinc	6.3E+03	1.00	8.2E-03	2.7E-02	3.0E-01	3E-02	9E-02					
Total						9E-02	3E-01					

Population Child High Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Dermal Contact

HIFs	CTE	RME
Noncancer	1.42E-06	1.18E-05
Cancer	4.04E-08	1.01E-06

			Non-Cancer					Cancer				
	EPC	ABSd	DAD (mg/kg-d)		RfD	HQ		DAD (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.6E+01	0.001	6.6E-08	5.5E-07	2.5E-05	3E-03	2E-02					
Zinc	6.3E+03	NV										
Total						3E-03	2E-02					

Population Child High Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Inhalation of Particulates

TWFs	CTE	RME
Noncancer	3.29E-02	5.48E-02
Cancer	9.39E-04	4.70E-03

	Csoil		Non-Cancer					Cancer				
	EPC	PEF	EC (mg/m3)		RfC	HQ		EC (ug/m3)		iUR	Risk	
COPC	mg/kg	m^3/kg	CTE	RME	mg/m^3	CTE	RME	CTE	RME	$(ug/m^3)^{-1}$	CTE	RME
Cadmium	4.6E+01	1.36E+09	1.1E-09	1.9E-09	1.0E-05	1E-04	2E-04	3.2E-08	1.6E-07	1.8E-03	6E-11	3E-10
Zinc	6.3E+03											
Total						1E-04	2E-04				6E-11	3E-10

APPENDIX E. NON-LEAD RISK CALCULATIONS

Population	Adult Low Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Incidental Ingestion

HIFs	CTE	RME
Noncancer	4.11E-08	2.47E-07
Cancer	5.28E-09	9.16E-08

			Non-Cancer					Cancer				
	EPC	RBA	DI (mg/kg-d)		RfD	HQ		DI (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.7E+01	1.00	1.9E-06	1.2E-05	1.0E-03	2E-03	1E-02					
Zinc	6.7E+03	1.00	2.7E-04	1.6E-03	3.0E-01	9E-04	5E-03					
Total						3E-03	2E-02					

Population	Adult Low Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Dermal Contact

HIFs	CTE	RME
Noncancer	4.96E-08	1.04E-06
Cancer	6.37E-09	3.87E-07

			Non-Cancer					Cancer				
	EPC	ABSd	DAD (mg/kg-d)		RfD	HQ		DAD (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.7E+01	0.001	2.3E-09	4.9E-08	2.5E-05	9E-05	2E-03					
Zinc	6.7E+03	NV										
Total						9E-05	2E-03					

Population	Adult Low Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Inhalation of Particulates

TWFs	CTE	RME
Noncancer	1.10E-02	3.29E-02
Cancer	1.41E-03	1.22E-02

	Csoil		Non-Cancer					Cancer				
	EPC	PEF	EC (mg/m3)		RfC	HQ		EC (ug/m3)		iUR	Risk	
COPC	mg/kg	m^3/kg	CTE	RME	mg/m^3	CTE	RME	CTE	RME	$(ug/m^3)^{-1}$	CTE	RME
Cadmium	4.7E+01	1.36E+09	3.8E-10	1.1E-09	1.0E-05	4E-05	1E-04	4.9E-08	4.2E-07	1.8E-03	9E-11	8E-10
Zinc	6.7E+03											
Total						4E-05	1E-04				9E-11	8E-10

APPENDIX E. NON-LEAD RISK CALCULATIONS

Population Adolescent Low Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Incidental Ingestion

HIFs	CTE	RME
Noncancer	7.42E-08	4.45E-07
Cancer	3.18E-09	6.36E-08

			Non-Cancer					Cancer				
	EPC	RBA	DI (mg/kg-d)		RfD	HQ		DI (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.7E+01	1.00	3.5E-06	2.1E-05	1.0E-03	3E-03	2E-02					
Zinc	6.7E+03	1.00	5.0E-04	3.0E-03	3.0E-01	2E-03	1E-02					
Total						5E-03	3E-02					

Population Adolescent Low Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Dermal Contact

HIFs	CTE	RME
Noncancer	2.68E-07	8.05E-06
Cancer	1.15E-08	1.15E-06

			Non-Cancer					Cancer				
	EPC	ABSd	DAD (mg/kg-d)		RfD	HQ		DAD (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.7E+01	0.001	1.3E-08	3.8E-07	2.5E-05	5E-04	2E-02					
Zinc	6.7E+03	NV										
Total						5E-04	2E-02					

Population Adolescent Low Frequency Recreational Visitor
Medium Surface Soil
Exposure Route Inhalation of Particulates

TWFs	CTE	RME
Noncancer	1.10E-02	3.29E-02
Cancer	4.70E-04	4.70E-03

	Csoil		Non-Cancer					Cancer				
	EPC	PEF	EC (mg/m3)		RfC	HQ		EC (ug/m3)		iUR	Risk	
COPC	mg/kg	m^3/kg	CTE	RME	mg/m^3	CTE	RME	CTE	RME	$(ug/m^3)^{-1}$	CTE	RME
Cadmium	4.7E+01	1.36E+09	3.8E-10	1.1E-09	1.0E-05	4E-05	1E-04	1.6E-08	1.6E-07	1.8E-03	3E-11	3E-10
Zinc	6.7E+03											
Total						4E-05	1E-04				3E-11	3E-10

APPENDIX E. NON-LEAD RISK CALCULATIONS

Population	Child Low Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Incidental Ingestion

HIFs	CTE	RME
Noncancer	4.38E-07	2.63E-06
Cancer	1.25E-08	2.25E-07

			Non-Cancer					Cancer				
	EPC	RBA	DI (mg/kg-d)		RfD	HQ		DI (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.7E+01	1.00	2.1E-05	1.2E-04	1.0E-03	2E-02	1E-01					
Zinc	6.7E+03	1.00	2.9E-03	1.8E-02	3.0E-01	1E-02	6E-02					
Total						3E-02	2E-01					

Population	Child Low Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Dermal Contact

HIFs	CTE	RME
Noncancer	4.72E-07	7.08E-06
Cancer	1.35E-08	6.06E-07

			Non-Cancer					Cancer				
	EPC	ABSd	DAD (mg/kg-d)		RfD	HQ		DAD (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.7E+01	0.001	2.2E-08	3.3E-07	2.5E-05	9E-04	1E-02					
Zinc	6.7E+03	NV										
Total						9E-04	1E-02					

Population	Child Low Frequency Recreational Visitor
Medium	Surface Soil
Exposure Route	Inhalation of Particulates

TWFs	CTE	RME
Noncancer	1.10E-02	3.29E-02
Cancer	3.13E-04	2.82E-03

	Csoil		Non-Cancer					Cancer				
	EPC	PEF	EC (mg/m3)		RfC	HQ		EC (ug/m3)		iUR	Risk	
COPC	mg/kg	m^3/kg	CTE	RME	mg/m^3	CTE	RME	CTE	RME	(ug/m^3)$^{-1}$	CTE	RME
Cadmium	4.7E+01	1.36E+09	3.8E-10	1.1E-09	1.0E-05	4E-05	1E-04	1.1E-08	9.7E-08	1.8E-03	2E-11	2E-10
Zinc	6.7E+03											
Total						4E-05	1E-04				2E-11	2E-10

APPENDIX E. NON-LEAD RISK CALCULATIONS

Population: Adult Construction Worker
Medium: Surface Soil and Subsurface Soil
Exposure Route: Incidental Ingestion

HIFs	CTE	RME
Noncancer	7.50E-07	2.83E-06
Cancer	5.36E-09	4.04E-08

			Non-Cancer					Cancer				
	EPC	RBA	DI (mg/kg-d)		RfD	HQ		DI (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.4E+01	1.00	3.3E-05	1.2E-04	1.0E-03	3E-02	1E-01					
Zinc	6.1E+03	1.00	4.6E-03	1.7E-02	3.0E-01	2E-02	6E-02					
Total						5E-02	2E-01					

Population: Adult Construction Worker
Medium: Surface Soil and Subsurface Soil
Exposure Route: Dermal Contact

HIFs	CTE	RME
Noncancer	2.60E-06	8.91E-06
Cancer	1.86E-08	1.27E-07

			Non-Cancer					Cancer				
	EPC	ABSd	DAD (mg/kg-d)		RfD	HQ		DAD (mg/kg-d)		oSF	Risk	
COPC	mg/kg		CTE	RME	mg/kg-d	CTE	RME	CTE	RME	(mg/kg-d)-1	CTE	RME
Cadmium	4.4E+01	0.001	1.1E-07	3.9E-07	2.5E-05	5E-03	2E-02					
Zinc	6.1E+03	NV										
Total						5E-03	2E-02					

Population: Adult Construction Worker
Medium: Surface Soil and Subsurface Soil
Exposure Route: Inhalation of Particulates

TWFs	CTE	RME
Noncancer	2.00E-01	2.28E-01
Cancer	1.43E-03	3.26E-03

	Csoil		Non-Cancer					Cancer				
	EPC	PEF	EC (mg/m3)		RfC	HQ		EC (ug/m3)		iUR	Risk	
COPC	mg/kg	m^3/kg	CTE	RME	mg/m^3	CTE	RME	CTE	RME	$(ug/m^3)^{-1}$	CTE	RME
Cadmium	4.4E+01	3.20E+06	2.7E-06	3.1E-06	1.0E-05	3E-01	3E-01	1.9E-05	4.5E-05	1.8E-03	4E-08	8E-08
Zinc	6.1E+03											
Total						3E-01	3E-01				4E-08	8E-08

APPENDIX F

DETAILED LEAD RISK CALCULATIONS

APPENDIX F

IEUBK OUTPUT

Recreational Child Lead Risk Calculations
High-Frequency Use Areas

LEAD MODEL FOR WINDOWS Version 1.1

==

Model Version: 1.1 Build11
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

******** Soil & Dust ********

Multiple Source Analysis Used
Average multiple source concentration: 203.200 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	276.000	203.200
1-2	276.000	203.200
2-3	276.000	203.200
3-4	276.000	203.200
4-5	276.000	203.200
5-6	276.000	203.200
6-7	276.000	203.200

******** Alternate Intake ********

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

******** Maternal Contribution: Infant Model ********

Maternal Blood Concentration: 1.000 µg Pb/dL

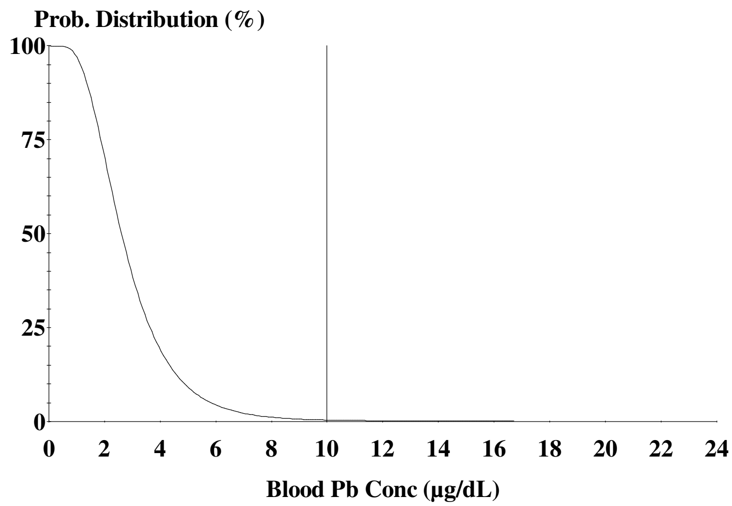
****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	1.060	0.000	0.375
1-2	0.034	0.911	0.000	0.929
2-3	0.062	0.999	0.000	0.976
3-4	0.067	0.966	0.000	1.004
4-5	0.067	0.938	0.000	1.059
5-6	0.093	0.993	0.000	1.123
6-7	0.093	1.078	0.000	1.146

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)

.5-1	4.141	5.598	3.0
1-2	6.512	8.387	3.5
2-3	6.575	8.612	3.2
3-4	6.635	8.671	3.0
4-5	4.996	7.060	2.5
5-6	4.524	6.733	2.1
6-7	4.287	6.605	1.9

IEUBK Distribution Probability Percent



Cutoff = 10.000 µg/dl
Geo Mean = 2.735
GSD = 1.600
% Above = 0.291

Age Range = 0 to 84 months

Run Mode = Research

APPENDIX F

IEUBK OUTPUT

Recreational Child Lead Risk Calculations
Low-Frequency Use Areas

LEAD MODEL FOR WINDOWS Version 1.1

==
==

Model Version: 1.1 Build11
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==
==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 80.000 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	100.000	80.000
1-2	100.000	80.000
2-3	100.000	80.000
3-4	100.000	80.000
4-5	100.000	80.000
5-6	100.000	80.000
6-7	100.000	80.000

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 1.000 µg Pb/dL

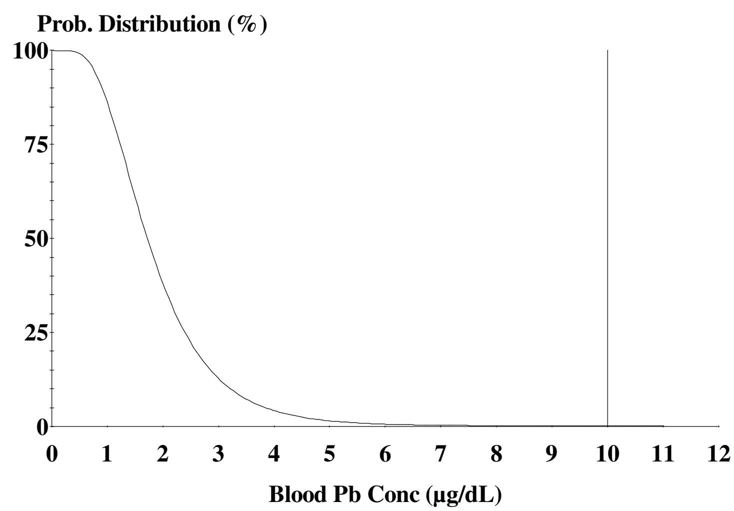
****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	1.084	0.000	0.384
1-2	0.034	0.935	0.000	0.955
2-3	0.062	1.023	0.000	0.999
3-4	0.067	0.985	0.000	1.024
4-5	0.067	0.951	0.000	1.073
5-6	0.093	1.003	0.000	1.135
6-7	0.093	1.088	0.000	1.157

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)

.5-1	2.178	3.667	2.0
1-2	3.441	5.365	2.2
2-3	3.461	5.544	2.1
3-4	3.481	5.557	2.0
4-5	2.604	4.693	1.7
5-6	2.351	4.583	1.4
6-7	2.225	4.563	1.3

IEUBK Distribution Probability Percent



Cutoff = 10.000 µg/dl
Geo Mean = 1.802
GSD = 1.600
% Above = 0.013

Age Range = 0 to 84 months

Run Mode = Research

APPENDIX F

ALM OUTPUT

Exposed Pop.	High Frequency Recreational Visitor
Exposure Model	ALM
Source	NHANES 1999-2004

Parameters	Value	Units
PbB0	1.0	ug/dL
BKSF	0.4	ug/dL per ug/day
GSD	1.8	--
PEF	1.36E+09	m3/kg

Scenario	Parameters	Units	Value
Incidental ingestion of floodplain soil	Lead Conc	ug/g	603
	Intake rate	g/day	0.05
	Exp Freq	days/yr	72
	Abs Fraction	--	8.8%
	Abs Dose	ug/day	0.52
	GM PbB (ug/dL)	ug/dL	1.2
	P10 (%)		0.0%
Inhalation of particulates while recreating	Lead Conc (soil)	mg/kg	603
	Lead conc (air)	ug/m3	0.000
	Breathing rate	m3/hr	0.6
	Exp Time	hr/day	1.0
	Exp Freq	days/yr	72
	Abs Fraction	--	12%
	Abs Dose	ug/day	6.6E-06
	GM PbB (ug/dL)	ug/dL	1.0
	P10 (%)		0.0%
All	Abs. Dose	ug/day	0.52
	GM PbB (ug/dL)	ug/dL	1.21
	P10 (%)		0.01%

Exposed Pop.	Low Frequency Recreational Visitor
Exposure Model	ALM
Source	NHANES 1999-2004

Parameters	Value	Units
PbB0	1.0	ug/dL
BKSF	0.4	ug/dL per ug/day
GSD	1.8	--
PEF	1.36E+09	m3/kg

Scenario	Parameters	Units	Value
Incidental ingestion of floodplain soil	Lead Conc	ug/g	520
	Intake rate	g/day	0.05
	Exp Freq	days/yr	24
	Abs Fraction	--	12.2%
	Abs Dose	ug/day	0.21
	GM PbB (ug/dL)	ug/dL	1.1
	P10 (%)		0.0%
Inhalation of particulates while recreating	Lead Conc (soil)	mg/kg	520
	Lead conc (air)	ug/m3	0.0004
	Breathing rate	m3/hr	0.6
	Exp Time	hr/day	1.0
	Exp Freq	days/yr	24
	Abs Fraction	--	12%
	Abs Dose	ug/day	1.9E-06
	GM PbB (ug/dL)	ug/dL	1.0
	P10 (%)		0.0%
All	Abs. Dose	ug/day	0.21
	GM PbB (ug/dL)	ug/dL	1.08
	P10 (%)		0.00%

APPENDIX F. RISKS FROM LEAD

Exposed Pop.	Construction Worker
Exposure Model	ALM
Source	NHANES 1999-2004

Parameters	Value	Units
PbB0	1.0	ug/dL
BKSF	0.4	ug/dL per ug/day
GSD	1.8	--
PEF	1.36E+09	m3/kg

Scenario	Parameters	Units	Value
Incidental ingestion of floodplain soil	Lead Conc	ug/g	529
	Intake rate	g/day	0.10
	Exp Freq	days/yr	219
	Abs Fraction	--	10.2%
	Abs Dose	ug/day	3.24
	GM PbB (ug/dL)	ug/dL	2.3
	P10 (%)		0.4%
Inhalation of particulates while recreating	Lead Conc (soil)	mg/kg	529
	Lead conc (air)	ug/m3	0.0004
	Breathing rate	m3/hr	0.6
	Exp Time	hr/day	1.0
	Exp Freq	days/yr	219
	Abs Fraction	--	12%
	Abs Dose	ug/day	1.8E-05
	GM PbB (ug/dL)	ug/dL	1.0
	P10 (%)		0.0%
All	Abs. Dose	ug/day	3.24
	GM PbB (ug/dL)	ug/dL	2.30
	P10 (%)		0.37%

APPENDIX G

RAGS D TABLES

TABLE 1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Cherokee County OU8 - Rail Lines

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Soil	Soils collected up to a depth of 4 feet[a]	Main Rail Line	High-frequency Recreator	Adult / Adolescent/ Child	Ingestion Dermal	On-Site	Quantitative	Incidental ingestion of and dermal contact with contaminated soil by future high-frequency recreator populations will be evaluated quantitatively.
						Inhalation			Incidental inhalation of contaminated particulates by future high-frequency recreator populations will be evaluated quantitatively.
				Low-frequency Recreator	Adult / Adolescent/ Child	Ingestion Dermal	On-Site	Quantitative	Incidental ingestion of and dermal contact with contaminated soil by future low-frequency recreator populations will be evaluated quantitatively.
						Inhalation			Incidental inhalation of contaminated particulates by future low-frequency recreator populations will be evaluated quantitatively.
				Construction Worker	Adult	Ingestion Dermal	On-Site	Quantitative	Incidental ingestion of and dermal contact with contaminated soil during work activities is possible. Therefore, this pathway will be evaluated quantitatively.
						Inhalation			Incidental inhalation of contaminated particulates during work activities is possible. Therefore, this pathway will be evaluated quantitatively.

[a] Exposure to the soils at the Cherokee County Rail Lines site will differ for individual receptors based on sample depth. High and low-frequency recreators are assumed to be exposed to surface soils (soil samples collected from the top 6 inches). Current or potential future construction workers are assumed to be exposed to subsurface soils (samples collected from the top 4 feet of soil).

COPC = Contaminant of Potential Concern; HHRA = Human Health Risk Assessment

TABLE 3.1

EXPOSURE POINT CONCENTRATION (EPC) SUMMARY

HIGH-FREQUENCY RECREATOR SOIL EPCs

Cherokee County OU8 - Rail Lines

Scenario Timeframe: Current/Future
Medium: Surface Soils
Exposure Medium: High Frequency Recreational Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) [1]	Maximum Concentration	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Main Rail Lines	Cadmium	mg/kg	37	46 (N)	89	46	mg/kg	95% Student's-t UCL	ProUCL
	Lead	mg/kg	603	--	1700				
	Zinc	mg/kg	5334	6257 (N)	9435	6257	mg/kg	95% Student's-t UCL	ProUCL

Abbreviations:

EPC = Exposure Point Concentration
N = Normal
ProUCL = UCL statistic recommended by USEPA's ProUCL software (version 5.0), based on the distribution of the data

Notes:

[1] Risks to lead are evaluated based on a mean concentration; a 95th UCL was not calculated.

TABLE 3.2

EXPOSURE POINT CONCENTRATION (EPC) SUMMARY

LOW-FREQUENCY RECREATOR SOIL EPCs

Cherokee County OU8 - Rail Lines

Scenario Timeframe: Current/Future
Medium: Surface Soils
Exposure Medium: Low Frequency Recreational Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) [1]	Maximum Concentration	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Main Rail Lines	Cadmium	mg/kg	40	46.86 (N)	100	46.86	mg/kg	95% Student's-t UCL	ProUCL
	Lead	mg/kg	520	--	1999				
	Zinc	mg/kg	6036	6673 (G)	13834	6673	mg/kg	95% Approximate Gamma UCL	ProUCL

Abbreviations:

EPC = Exposure Point Concentration
G = Gamma
N = Normal
ProUCL = UCL statistic recommended by USEPA's ProUCL software (version 5.0), based on the distribution of the data

Notes:

[1] Risks to lead are evaluated based on a mean concentration; a 95th UCL was not calculated.

TABLE 3.3

EXPOSURE POINT CONCENTRATION (EPC) SUMMARY

CONSTRUCTION WORKER SOIL EPCs

Cherokee County OU8 - Rail Lines

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soils
Exposure Medium: Construction Worker Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) [1]	Maximum Concentration	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Main Rail Lines	Cadmium	mg/kg	39	44 (NP)	113	44	mg/kg	95% KM (BCA) UCL	ProUCL
	Lead	mg/kg	529	--	19575				
	Zinc	mg/kg	5159	6087 (NP)	27222	6087	mg/kg	95% Chebyshev (Mean, Sd) UCL	ProUCL

Abbreviations:

EPC = Exposure Point Concentration
NP = Non-parametric
ProUCL = UCL statistic recommended by USEPA's ProUCL software (version 5.0), based on the distribution of the data

Notes:

[1] Risks to lead are evaluated based on a mean concentration; a 95th UCL was not calculated.

Table 4.1
Values Used for Daily Intake Calculations
Cherokee County OU8 - Rail Lines

Scenario Time Frame: Current/Future
Medium: Rail line soils
Exposure Medium: Surface Soil
Exposure Points: Main Rail Line
Receptor Population: High-frequency Recreational Visit
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	BW	Body weight	kg	80	[1]	80	[1]	Chronic Daily Intake (CDI) (mg/kg-day)= CS x CF x IR x EF x ED / (BW x AT)
	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	
	ED	Exposure duration	years	26	[1,3,5,c]	9	[3, 5, b]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	9,490	[2,d]	3,285	[2,d]	
	CF	Conversion factor	kg/mg	0.000001	unit conversion	0.000001	unit conversion	
	IR	Ingestion rate	mg soil/day	100	[1, 3, f]	50	[3,e]	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Dermal	BW	Body weight	kg	80	[1]	80	[1]	Dermally Absorbed Dose (DAD) (mg/kg-day)= CS x CF x SA x AF x EF x ED x ABS / (BW x AT)
	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	
	ED	Exposure duration	years	26	[1,3,5,c]	9	[3, 5, b]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	9,490	[2,d]	3,285	[2,d]	
	SA	Skin surface area available for contact	cm^2	6,032	[1,3,g]	6,032	[1,3,g]	
	AF	Sediment/soil-to-skin adherence factor	mg/cm^2	0.07	[1,3,h]	0.01	[3,4,h]	
	ABS	Dermal absorption factor - all COPCs	unitless	Chemical-specific, see Table 5.1	[4]	Chemical-specific, see Table 5.1	[4]	
	CF	Conversion factor	kg/mg	1E-06	unit conversion	1E-06	unit conversion	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Inhalation	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	Exposure Concentration (ug/m^3) = CA x ET x EF x ED / AT
	ED	Exposure duration	years	26	[1,3,5,c]	9	[3, 5, b]	
	AT	Averaging time - carcinogens	hours	613,200	[2]	613,200	[2]	
	AT	Averaging time - non-carcinogens	hours	227,760	[2]	78,840	[2]	
	ET	Exposure time	hours/day	4	[3]	4	[3]	
	CA	Chemical concentration in air	$\mu g/m^3$	EPC	See table 3.1	EPC	See table 3.1	

NA = not applicable; EPC = exposure point concentration

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.
[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. Dec
[3] Professional judgment.
[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.
[5] USEPA 2011. Exposure Factors Handbook.
[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 3 visits/week for a CTE visitor and 5 visits/week for an RME visitor.
[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).
(2011).
[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.
[e] Assumes CTE value is half of the RME value.
[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.
[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.
[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).
[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.
[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.
[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.
[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)
[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.

Table 4.2
Values Used for Daily Intake Calculations
Cherokee County OU8 - Rail Lines

Scenario Time Frame: Current/Future
Medium: Rail line soils
Exposure Medium: Surface Soil
Exposure Points: Main Rail Line
Receptor Population: High-frequency Recreational Visit
Receptor Age: Adolescent (6-16 years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	BW	Body weight	kg	44.3	[5,j]	44.3	[5,j]	Chronic Daily Intake (CDI) (mg/kg-day)= CS x CF x IR x EF x ED / (BW x AT)
	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	
	ED	Exposure duration	years	10	[3]	3	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	3,650	[2,d]	1,095	[2,d]	
	CF	Conversion factor	kg/mg	0.000001	unit conversion	0.000001	unit conversion	
	IR	Ingestion rate	mg soil/day	100	[6]	50	[6,e]	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Dermal	BW	Body weight	kg	44.3	[5,j]	44.3	[5,j]	Dermally Absorbed Dose (DAD) (mg/kg-day)= CS x CF x SA x AF x EF x ED x ABS / (BW x AT)
	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	
	ED	Exposure duration	years	10	[3]	3	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	3,650	[2,d]	1,095	[2,d]	
	SA	Skin surface area available for contact	cm^2	4,520	[3,5,k]	4,520	[3,5,k]	
	AF	Sediment/soil-to-skin adherence factor	mg/cm^2	0.4	[3,4,i]	0.04	[3,4,i]	
	ABS	Dermal absorption factor - all COPCs	unitless	Chemical-specific, see Table 5.1	[4]	Chemical-specific, see Table 5.1	[4]	
	CF	Conversion factor	kg/mg	1E-06	unit conversion	1E-06	unit conversion	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Inhalation	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	Exposure Concentration (ug/m^3) = CA x ET x EF x ED / AT
	ED	Exposure duration	years	10	[3]	3	[3,l]	
	AT	Averaging time - carcinogens	hours	613,200	[2]	613,200	[2]	
	AT	Averaging time - non-carcinogens	hours	87,600	[2]	26,280	[2]	
	ET	Exposure time	hours/day	4	[3]	4	[3]	
	CA	Chemical concentration in air	$\mu g/m^3$	EPC	See table 3.1	EPC	See table 3.1	

NA = not applicable; EPC = exposure point concentration

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.
[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. Dec
[3] Professional judgment.
[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.
[5] USEPA 2011. Exposure Factors Handbook.
[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 3 visits/week for a CTE visitor and 5 visits/week for an RME visitor.
[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).
(2011).
[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.
[e] Assumes CTE value is half of the RME value.
[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.
[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.
[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).
[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.
[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.
[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.
[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)
[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.

Table 4.3
Values Used for Daily Intake Calculations
Cherokee County OU8 - Rail Lines

Scenario Time Frame: Current/Future
Medium: Rail line soils
Exposure Medium: Surface Soil
Exposure Points: Main Rail Line
Receptor Population: High-frequency Recreational Visit
Receptor Age: Child (0-6 years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	BW	Body weight	kg	15	[1]	15	[1]	Chronic Daily Intake (CDI) (mg/kg-day)= CS x CF x IR x EF x ED / (BW x AT)
	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	
	ED	Exposure duration	years	6	[1]	2	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	2,190	[2,d]	730	[2,d]	
	CF	Conversion factor	kg/mg	0.000001	unit conversion	0.000001	unit conversion	
	IR	Ingestion rate	mg soil/day	200	[1,3,f]	100	[3,e]	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Dermal	BW	Body weight	kg	15	[1]	15	[1]	Dermally Absorbed Dose (DAD) (mg/kg-day)= CS x CF x SA x AF x EF x ED x ABS / (BW x AT)
	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	
	ED	Exposure duration	years	6	[1]	2	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	2,190	[2,d]	730	[2,d]	
	SA	Skin surface area available for contact	cm^2	2,690	[1,3,g]	2,690	[1,3,g]	
	AF	Sediment/soil-to-skin adherence factor	mg/cm^2	0.2	[1,3,h]	0.04	[3,4,m]	
	ABS	Dermal absorption factor - all COPCs	unitless	Chemical-specific, see Table 5.1	[4]	Chemical-specific, see Table 5.1	[4]	
	CF	Conversion factor	kg/mg	1E-06	unit conversion	1E-06	unit conversion	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Inhalation	EF	Exposure frequency	days/year	120	[3, a]	72	[3, a]	Exposure Concentration (ug/m^3) = CA x ET x EF x ED / AT
	ED	Exposure duration	years	6	[1]	2	[3,l]	
	AT	Averaging time - carcinogens	hours	613,200	[2,d]	613,200	[2,d]	
	AT	Averaging time - non-carcinogens	hours	52,560	[2,d]	17,520	[2,d]	
	ET	Exposure time	hours/day	4	[3]	4	[3]	
	CA	Chemical concentration in air	$\mu g/m^3$	EPC	See table 3.1	EPC	See table 3.1	

NA = not applicable; EPC = exposure point concentration

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.
[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. Dec
[3] Professional judgment.
[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.
[5] USEPA 2011. Exposure Factors Handbook.
[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 3 visits/week for a CTE visitor and 5 visits/week for an RME visitor.
[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).
(2011).
[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.
[e] Assumes CTE value is half of the RME value.
[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.
[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.
[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).
[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.
[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.
[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.
[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)
[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.

Table 4.4
Values Used for Daily Intake Calculations
Cherokee County OU8 - Rail Lines

Scenario Time Frame: Current/Future
Medium: Rail line soils
Exposure Medium: Surface Soil
Exposure Points: Main Rail Line
Receptor Population: Low-frequency Recreational Visitor
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	BW	Body weight	kg	80	[1]	80	[1]	Chronic Daily Intake (CDI) (mg/kg-day)= CS x CF x IR x EF x ED / (BW x AT)
	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	
	ED	Exposure duration	years	26	[1,3,5,c]	9	[3, 5, b]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	9,490	[2,d]	3,285	[2,d]	
	CF	Conversion factor	kg/mg	0.000001	unit conversion	0.000001	unit conversion	
	IR	Ingestion rate	mg soil/day	100	[1, 3, f]	50	[3,e]	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Dermal	BW	Body weight	kg	80	[1]	80	[1]	Dermally Absorbed Dose (DAD) (mg/kg-day)= CS x CF x SA x AF x EF x ED x ABS / (BW x AT)
	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	
	ED	Exposure duration	years	26	[1,3,5,c]	9	[3, 5, b]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	9,490	[2,d]	3,285	[2,d]	
	SA	Skin surface area available for contact	cm^2	6,032	[1,3,g]	6,032	[1,3,g]	
	AF	Sediment/soil-to-skin adherence factor	mg/cm^2	0.07	[1,3,h]	0.01	[3,4,h]	
	ABS	Dermal absorption factor - all COPCs	unitless	Chemical-specific, see Table 5.1	[4]	Chemical-specific, see Table 5.1	[4]	
	CF	Conversion factor	kg/mg	1E-06	unit conversion	1E-06	unit conversion	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Inhalation	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	Exposure Concentration (ug/m^3) = CA x ET x EF x ED / AT
	ED	Exposure duration	years	26	[1,3,5,c]	9	[3, 5, b]	
	AT	Averaging time - carcinogens	hours	613,200	[2]	613,200	[2]	
	AT	Averaging time - non-carcinogens	hours	227,760	[2]	78,840	[2]	
	ET	Exposure time	hours/day	4	[3]	4	[3]	
	CA	Chemical concentration in air	$\mu g/m^3$	EPC	See table 3.1	EPC	See table 3.1	

NA = not applicable; EPC = exposure point concentration

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.
[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. Dec
[3] Professional judgment.
[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.
[5] USEPA 2011. Exposure Factors Handbook. EPA/600/R-090/052F.
[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 1 visit/week for a CTE visitor and 3 visits/week for an RME visitor.
[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).
[c] Assumes that area residents make up the majority of the recreational visitor population. Value of 26 years is based on the 90th percentile residential occupancy period presented in Table 16-108 of EFH
[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.
[e] Assumes CTE value is half of the RME value.
[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.
[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.
[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).
[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.
[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.
[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.
[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)
[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.
[l] Assumes the soil ingestion rate for an adolescent is twice that of an adult.

Table 4.5
Values Used for Daily Intake Calculations
Cherokee County OU8 - Rail Lines

Scenario Time Frame: Current/Future
Medium: Rail line soils
Exposure Medium: Surface Soil
Exposure Points: Main Rail Line
Receptor Population: Low-frequency Recreational Visitor
Receptor Age: Adolescent (6-16 years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	BW	Body weight	kg	44.3	[5,j]	44.3	[5,j]	Chronic Daily Intake (CDI) (mg/kg-day)= CS x CF x IR x EF x ED / (BW x AT)
	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	
	ED	Exposure duration	years	10	[3]	3	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	3,650	[2,d]	1,095	[2,d]	
	CF	Conversion factor	kg/mg	0.000001	unit conversion	0.000001	unit conversion	
	IR	Ingestion rate	mg soil/day	100	[6]	50	[6,e]	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Dermal	BW	Body weight	kg	44.3	[5,j]	44.3	[5,j]	Dermally Absorbed Dose (DAD) (mg/kg-day)= CS x CF x SA x AF x EF x ED x ABS / (BW x AT)
	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	
	ED	Exposure duration	years	10	[3]	3	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	3,650	[2,d]	1,095	[2,d]	
	SA	Skin surface area available for contact	cm^2	4,520	[3,5,k]	4,520	[3,5,k]	
	AF	Sediment/soil-to-skin adherence factor	mg/cm^2	0.4	[3,4,i]	0.04	[3,4,i]	
	ABS	Dermal absorption factor - all COPCs	unitless	Chemical-specific, see Table 5.1	[4]	Chemical-specific, see Table 5.1	[4]	
	CF	Conversion factor	kg/mg	1E-06	unit conversion	1E-06	unit conversion	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Inhalation	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	Exposure Concentration (ug/m^3) = CA x ET x EF x ED / AT
	ED	Exposure duration	years	10	[3]	3	[3,l]	
	AT	Averaging time - carcinogens	hours	613,200	[2]	613,200	[2]	
	AT	Averaging time - non-carcinogens	hours	87,600	[2]	26,280	[2]	
	ET	Exposure time	hours/day	4	[3]	4	[3]	
	CA	Chemical concentration in air	$\mu g/m^3$	EPC	See table 3.1	EPC	See table 3.1	

NA = not applicable; EPC = exposure point concentration

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. Dec

[3] Professional judgment.

[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.

[5] USEPA 2011. Exposure Factors Handbook.

[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 4 visits/week for a CTE visitor and 7 visits/week for an RME visitor.

[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).

(2011).

[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.

[e] Assumes CTE value is half of the RME value.

[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.

[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.

[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).

[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.

[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.

[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.

[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)

[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.

Table 4.6
Values Used for Daily Intake Calculations
Cherokee County OU8 - Rail Lines

Scenario Time Frame: Current/Future
Medium: Rail line soils
Exposure Medium: Surface Soil
Exposure Points: Main Rail Line
Receptor Population: Low-frequency Recreational Visitor
Receptor Age: Child (0-6 years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	BW	Body weight	kg	15	[1]	15	[1]	Chronic Daily Intake (CDI) (mg/kg-day)= CS x CF x IR x EF x ED / (BW x AT)
	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	
	ED	Exposure duration	years	6	[1]	2	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	2,190	[2,d]	730	[2,d]	
	CF	Conversion factor	kg/mg	0.000001	unit conversion	0.000001	unit conversion	
	IR	Ingestion rate	mg soil/day	200	[1,3,f]	100	[3,e]	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Dermal	BW	Body weight	kg	15	[1]	15	[1]	Dermally Absorbed Dose (DAD) (mg/kg-day)= CS x CF x SA x AF x EF x ED x ABS / (BW x AT)
	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	
	ED	Exposure duration	years	6	[1]	2	[3,l]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	2,190	[2,d]	730	[2,d]	
	SA	Skin surface area available for contact	cm^2	2,690	[1,3,g]	2,690	[1,3,g]	
	AF	Sediment/soil-to-skin adherence factor	mg/cm^2	0.2	[1,3,h]	0.04	[3,4,m]	
	ABS	Dermal absorption factor - all COPCs	unitless	Chemical-specific, see Table 5.1	[4]	Chemical-specific, see Table 5.1	[4]	
	CF	Conversion factor	kg/mg	1E-06	unit conversion	1E-06	unit conversion	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Inhalation	EF	Exposure frequency	days/year	72	[3, a]	24	[3, a]	Exposure Concentration (ug/m^3) = CA x ET x EF x ED / AT
	ED	Exposure duration	years	6	[1]	2	[3,l]	
	AT	Averaging time - carcinogens	hours	613,200	[2]	613,200	[2]	
	AT	Averaging time - non-carcinogens	hours	52,560	[2]	17,520	[2]	
	ET	Exposure time	hours/day	4	[3]	4	[3]	
	CA	Chemical concentration in air	$\mu g/m^3$	EPC	See table 3.1	EPC	See table 3.1	

NA = not applicable; EPC = exposure point concentration

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.
[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. Dec
[3] Professional judgment.
[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.
[5] USEPA 2011. Exposure Factors Handbook.
[6] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

Notes:

[a] Assumes exposure occurs over the course of 24 weeks when the ground is not covered with snow (May to September) at a frequency of 4 visits/week for a CTE visitor and 7 visits/week for an RME visitor.
[b] Assumes that area residents make up the majority of the recreational visitor population. Value of 9 years is based on mean residential occupancy period presented in Table 16-108 of EFH (2011).
(2011).
[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.
[e] Assumes CTE value is half of the RME value.
[f] Assumes that the RME soil ingestion rate by a recreational visitor is equal to the USEPA default soil ingestion rate for a resident.
[g] Assumes that the exposed surface area is equal to the USEPA default surface area for a resident which includes head, forearms, hands, lower legs and feet.
[h] Assumes adherence factor equal to the soil adherence factor for a resident (USEPA 2004, Exhibit 3-3).
[i] Exhibit 3-3. Assumes adherence factor equal to the 95th percentile for children age 8-12 years playing with dry soil for the RME value and equal to the geometric mean for the CTE value.
[j] Table 8-1. Time-weighted average for children aged 6 to <11 years and 11 to < 16 years.
[k] Tables 7-2 and 7-8. Time weighted average for older children/adolescents aged 6-16 years based on head, forearms, hands, lower legs and feet consistent with other receptors.
[l]Assumes same ratio of RME:CTE exposure duration as adult (9:26 years)
[m] Exhibit 3-3. Assumes adherence factor equal to the geometric mean for daycare children age 1-6.5 years playing indoors and outdoors.

Table 4.7
Values Used for Daily Intake Calculations
Cherokee County OU8 - Rail Lines

Scenario Time Frame: Current/Future
Medium: Rail line soils
Exposure Medium: Surface Soil and Subsurface Soil
Exposure Points: Main Rail Line
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	BW	Body weight	kg	80	[1]	80	[1]	Chronic Daily Intake (CDI) (mg/kg-day)= CS x CF x IR x EF x ED / (BW x AT)
	EF	Exposure frequency	days/year	250	[3, a]	219	[6]	
	ED	Exposure duration	years	1	[3,b]	0.5	[3,b]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	365	[2,d]	183	[2,d]	
	CF	Conversion factor	kg/mg	0.000001	unit conversion	0.000001	unit conversion	
	IR	Ingestion rate	mg soil/day	330	[8,c]	100	[6]	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Dermal	BW	Body weight	kg	80	[1]	80	[1]	Dermally Absorbed Dose (DAD) (mg/kg-day)= CS x CF x SA x AF x EF x ED x ABS / (BW x AT)
	EF	Exposure frequency	days/year	250	[3, a]	219	[6]	
	ED	Exposure duration	years	1	[3,b]	0.5	[3,b]	
	AT	Averaging time - carcinogens	days	25,550	[2,d]	25,550	[2,d]	
	AT	Averaging time - non-carcinogens	days	365	[2,d]	183	[2,d]	
	SA	Skin surface area available for contact	cm^2	3,470	[1,g]	3,470	[1,g]	
	AF	Sediment/soil-to-skin adherence factor	mg/cm^2	0.3	[4,h]	0.1	[4,h]	
	ABS	Dermal absorption factor - all COPCs	unitless	Chemical-specific, see Table 5.1	[4]	Chemical-specific, see Table 5.1	[4]	
	CF	Conversion factor	kg/mg	1E-06	unit conversion	1E-06	unit conversion	
	CS	Chemical concentration in soil	mg/kg	EPC	See table 3.1	EPC	See table 3.1	
Inhalation	EF	Exposure frequency	days/year	250	[3, a]	219	[6]	Exposure Concentration (ug/m^3) = CA x ET x EF x ED / AT
	ED	Exposure duration	years	1	[3,b]	0.5	[3,b]	
	AT	Averaging time - carcinogens	hours	613,200	[2]	613,200	[2]	
	AT	Averaging time - non-carcinogens	hours	8,760	[2]	4,392	[2]	
	ET	Exposure time	hours/day	8	[3,f]	8	[3,f]	
	CA	Chemical concentration in air	$\mu g/m^3$	EPC	See table 3.1	EPC	See table 3.1	

NA = not applicable; EPC = exposure point concentration

Sources:

[1] USEPA 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. February.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] Professional judgment.

[4] USEPA 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E). Office of Solid Waste and Emergency Response. July.

[5] USEPA 2011. Exposure Factors Handbook. EPA/600/R-090/052F.

[6] USEPA 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead. Final. EPA-540-R-03-001. January.

[7] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[8] USEPA 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.

Notes:

[a] Assumes exposure frequency of 5 days/week for a RME receptor.

[b] Assumes construction/excavation project of 6 month (CTE) or 1 year (RME) duration.

[c] Exhibit 5-1. Default value for construction scenario (330 mg/day) is based on the 95th percentile value for adult soil intake rates reported in a soil ingestion mass-balance study.

[d] Averaging time expressed as days. Noncancer averaging time calculated by multiplying the exposure duration by 365 days/year. Cancer averaging time calculated by multiplying a 70 year lifetime for cancer effects by 365 days/year.

[e] Assumes CTE value is half of the RME value.

[f] Assumes the entire workday is outdoors.

[g] Assumes that the exposed surface area is equal to the USEPA default for a worker.

[h] Exhibit 3-3. 95th percentile value (0.3) assumed for the RME receptor and the geometric mean value (0.1) assumed for the CTE receptor.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
Cherokee County OU8 - Rail Lines

Chemical of Potential Concern	CAS	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal	Absorbed RfD for Dermal[1]		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD : Target Organ(s)	
			Value	Units		Value	Units			Source	Date(s) (MM/DD/YYYY
Cadmium	7440-43-9	Chronic	1.0E-03	mg/kg-day	0.025	2.5E-05	mg/kg-day	kidney	10 / 1	I	2/1/1994
Zinc	7440-66-6	Chronic	3.0E-01	mg/kg-day	1.00	3.0E-01	mg/kg-day	blood	3/1	I	8/3/2005

Source: EPA Regional Screening Level Table January 2015 (http://www.epa.gov/region9/superfund/prg/).

[1]Absorbed Reference Doses for Dermal were derived using the Oral Reference Dose as follows: $RFD_{ABS} = RfD_o * ABS_{GI}$ (Equation 4.3 from USEPA 2004)

RfD Sources: I = IRIS

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
Cherokee County OU8 - Rail Lines

Chemical of Potential Concern	CAS RN	Chronic/ Subchronic	Inhalation RfC		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	Data Source	
			Value	Units			Source	Date (MM/DD/YYYY)
Cadmium	7440-43-9	Chronic	1.00E-05	(mg/m^3)	Respiratory	3 / 3	A	09/2012
Zinc	7440-66-6		NV					

Source: EPA Regional Screening Level Table January 2015 (http://www.epa.gov/region9/superfund/prg/).

RfD Source: A = ATSDR
NV = no value

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
Cherokee County OU8 - Rail Lines

Chemical of Potential Concern	CAS	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal	Absorbed Cancer Slope Factor		Weight of Evidence/Cancer Guideline Description	Data Source	
		Value	Units		Value	Units		Source(s)	Dates(s) (MM/DD/YYYY)
Cadmium	7440-43-9	NV							
Zinc	7440-66-6	NV							

Source: EPA Regional Screening Level Table January 2015 (http://www.epa.gov/region9/superfund/prg/).

NV = no value

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
Cherokee County OU8 - Rail Lines

Chemical	CAS RN	Inhalation Unit Risk		Weight of Evidence/ Cancer Guideline Description	Data Source	
		Unit Risk	Units		Source(s)	Date(s) (MM/DD/YYYY)
Cadmium	7440-43-9	1.80E-03	$(\mu g/m^3)^{-1}$	B1	I	6/1/1992
Zinc	7440-66-6	NV				

Sources:
NV = no value
I = IRIS

Weight of Evidence/Cancer Guideline Description
A = Human carcinogen. Sufficient evidence of cancer in humans.
B1 - Probable human carcinogen indicates that limited human data are available.
B2 = Probably human carcinogen. Sufficieint evidence of cancer in animals, but lack of data or insufficient data from humans.
C = Possible human carcinogen
D = Cannot be evaluated. No evidence or inadequate evidence of cancer in animals or humans.
E = Not classified

TABLE 7.1.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
CENTRAL TENDENCY
Cherokee County OU8 - Rail Lines

Scenario Timeframe:	Current/Future
Receptor Population:	Adult
Receptor Age:	>16 years

Medium	Receptor	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
						Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
								Value	Units	Value	Units		Value	Units	Value	Units	
Soil	High-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						5.7E-06	mg/kg-d	1.0E-03	mg/kg-d	6E-03
					Zinc	6E+03	mg/kg						7.7E-04	mg/kg-d	3.0E-01	mg/kg-d	3E-03
				Exp. Route Total													8E-03
				Dermal	Cadmium	5E+01	mg/kg						6.9E-09	mg/kg-d	2.5E-05	mg/kg-d	3E-04
					Zinc	6E+03	mg/kg										
				Exp. Route Total													3E-04
				Inhalation	Cadmium	5E+01	mg/kg	1.4E-07	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	3E-10	1.1E-09	mg/kg-d	1.0E-05	mg/kg-d	1E-04
					Zinc	6E+03	mg/kg										
				Exp. Route Total								3E-10					1E-04
	Receptor Total											3E-10					9E-03
Soil	Low-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						1.9E-06	mg/kg-d	1.0E-03	mg/kg-d	2E-03
					Zinc	7E+03	mg/kg						2.7E-04	mg/kg-d	3.0E-01	mg/kg-d	9E-04
				Exp. Route Total													3E-03
				Dermal	Cadmium	5E+01	mg/kg						2.3E-09	mg/kg-d	2.5E-05	mg/kg-d	9E-05
					Zinc	7E+03	mg/kg										
				Exp. Route Total													9E-05
				Inhalation	Cadmium	5E+01	mg/kg	4.9E-08	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	9E-11	3.8E-10	mg/kg-d	1.0E-05	mg/kg-d	4E-05
					Zinc	7E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								9E-11					4E-05
	Receptor Total											9E-11					3E-03
Soil	Construction Worker	Surface Soil and Subsurface Soil	Main Rail Lines	Ingestion	Cadmium	4E+01	mg/kg						3.3E-05	mg/kg-d	1.0E-03	mg/kg-d	3E-02
					Zinc	6E+03	mg/kg						4.6E-03	mg/kg-d	3.0E-01	mg/kg-d	2E-02
				Exp. Route Total													5E-02
				Dermal	Cadmium	4E+01	mg/kg						1.1E-07	mg/kg-d	2.5E-05	mg/kg-d	5E-03
					Zinc	6E+03	mg/kg										
				Exp. Route Total													5E-03
				Inhalation	Cadmium	4E+01	mg/kg	1.9E-05	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	4E-08	2.7E-06	mg/kg-d	1.0E-05	mg/kg-d	3E-01
					Zinc	6E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								4E-08					3E-01
	Receptor Total											4E-08					3E-01
											Total of Receptor Risks Across All Media	4E-08				Total of Receptor Hazards Across All Receptors	3E-01

TABLE 7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Cherokee County OU8 - Rail Lines

Scenario Timeframe:	Current/Future
Receptor Population:	Adult
Receptor Age:	>16 years

Medium	Receptor	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
						Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
								Value	Units	Value	Units		Value	Units	Value	Units	
Soil	High-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						1.9E-05	mg/kg-d	1.0E-03	mg/kg-d	2E-02
					Zinc	6E+03	mg/kg						2.6E-03	mg/kg-d	3.0E-01	mg/kg-d	9E-03
				Exp. Route Total													3E-02
				Dermal	Cadmium	5E+01	mg/kg						8.1E-08	mg/kg-d	2.5E-05	mg/kg-d	3E-03
					Zinc	6E+03	mg/kg										
				Exp. Route Total													3E-03
				Inhalation	Cadmium	5E+01	mg/kg	7.0E-07	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	1E-09	1.9E-09	mg/kg-d	1.0E-05	mg/kg-d	2E-04
					Zinc	6E+03	mg/kg										
				Exp. Route Total								1E-09					2E-04
	Receptor Total											1E-09					3E-02
Soil	Low-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						1.2E-05	mg/kg-d	1.0E-03	mg/kg-d	1E-02
					Zinc	7E+03	mg/kg						1.6E-03	mg/kg-d	3.0E-01	mg/kg-d	5E-03
				Exp. Route Total													2E-02
				Dermal	Cadmium	5E+01	mg/kg						4.9E-08	mg/kg-d	2.5E-05	mg/kg-d	2E-03
					Zinc	7E+03	mg/kg										
				Exp. Route Total													2E-03
				Inhalation	Cadmium	5E+01	mg/kg	4.2E-07	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	8E-10	1.1E-09	mg/kg-d	1.0E-05	mg/kg-d	1E-04
					Zinc	7E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								8E-10					1E-04
	Receptor Total											8E-10					2E-02
Soil	Construction Worker	Surface Soil and Subsurface Soil	Main Rail Lines	Ingestion	Cadmium	4E+01	mg/kg						1.2E-04	mg/kg-d	1.0E-03	mg/kg-d	1E-01
					Zinc	6E+03	mg/kg						1.7E-02	mg/kg-d	3.0E-01	mg/kg-d	6E-02
				Exp. Route Total													2E-01
				Dermal	Cadmium	4E+01	mg/kg						3.9E-07	mg/kg-d	2.5E-05	mg/kg-d	2E-02
					Zinc	6E+03	mg/kg										
				Exp. Route Total													2E-02
				Inhalation	Cadmium	4E+01	mg/kg	4.5E-05	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	8E-08	3.1E-06	mg/kg-d	1.0E-05	mg/kg-d	3E-01
					Zinc	6E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								8E-08					3E-01
	Receptor Total											8E-08					5E-01
											Total of Receptor Risks Across All Media	8E-08	Total of Receptor Hazards Across All Receptors				6E-01

TABLE 7.2.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
CENTRAL TENDENCY
Cherokee County OU8 - Rail Lines

Scenario Timeframe:	Current/Future
Receptor Population:	Adolescent
Receptor Age:	6-16 yrs

Medium	Receptor	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
						Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
								Value	Units	Value	Units		Value	Units	Value	Units	
Soil	High-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						1.0E-05	mg/kg-d	1.0E-03	mg/kg-d	1E-02
					Zinc	6E+03	mg/kg						1.4E-03	mg/kg-d	3.0E-01	mg/kg-d	5E-03
				Exp. Route Total													1E-02
				Dermal	Cadmium	5E+01	mg/kg						3.7E-08	mg/kg-d	2.5E-05	mg/kg-d	1E-03
					Zinc	6E+03	mg/kg										
				Exp. Route Total													1E-03
				Inhalation	Cadmium	5E+01	mg/kg	4.8E-08	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	9E-11	1.1E-09	mg/kg-d	1.0E-05	mg/kg-d	1E-04
					Zinc	6E+03	mg/kg										
				Exp. Route Total								9E-11					1E-04
	Receptor Total											9E-11					2E-02
Soil	Low-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						3.5E-06	mg/kg-d	1.0E-03	mg/kg-d	3E-03
					Zinc	7E+03	mg/kg						5.0E-04	mg/kg-d	3.0E-01	mg/kg-d	2E-03
				Exp. Route Total													5E-03
				Dermal	Cadmium	5E+01	mg/kg						1.3E-08	mg/kg-d	2.5E-05	mg/kg-d	5E-04
					Zinc	7E+03	mg/kg										
				Exp. Route Total													5E-04
				Inhalation	Cadmium	5E+01	mg/kg	1.6E-08	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	3E-11	3.8E-10	mg/kg-d	1.0E-05	mg/kg-d	4E-05
					Zinc	7E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								3E-11					4E-05
	Receptor Total											3E-11					6E-03
											Total of Receptor Risks Across All Media	1E-10				Total of Receptor Hazards Across All Receptors	2E-02

TABLE 7.2.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Cherokee County OU8 - Rail Lines

Scenario Timeframe:	Current/Future
Receptor Population:	Adolescent
Receptor Age:	6-16 yrs

Medium	Receptor	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
						Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
								Value	Units	Value	Units		Value	Units	Value	Units	
Soil	High-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						3.4E-05	mg/kg-d	1.0E-03	mg/kg-d	3E-02
					Zinc	6E+03	mg/kg						4.6E-03	mg/kg-d	3.0E-01	mg/kg-d	2E-02
				Exp. Route Total													5E-02
				Dermal	Cadmium	5E+01	mg/kg						6.2E-07	mg/kg-d	2.5E-05	mg/kg-d	2E-02
					Zinc	6E+03	mg/kg										
				Exp. Route Total													2E-02
				Inhalation	Cadmium	5E+01	mg/kg	2.7E-07	mg/kg-d	1.8E-03	(μg/m^3)$^{-1}$	5E-10	1.9E-09	mg/kg-d	1.0E-05	mg/kg-d	2E-04
					Zinc	6E+03	mg/kg										
				Exp. Route Total								5E-10					2E-04
	Receptor Total											5E-10					8E-02
Soil	Low-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						2.1E-05	mg/kg-d	1.0E-03	mg/kg-d	2E-02
					Zinc	7E+03	mg/kg						3.0E-03	mg/kg-d	3.0E-01	mg/kg-d	1E-02
				Exp. Route Total													3E-02
				Dermal	Cadmium	5E+01	mg/kg						3.8E-07	mg/kg-d	2.5E-05	mg/kg-d	2E-02
					Zinc	7E+03	mg/kg										
				Exp. Route Total													2E-02
				Inhalation	Cadmium	5E+01	mg/kg	1.6E-07	mg/kg-d	1.8E-03	(μg/m^3)$^{-1}$	3E-10	1.1E-09	mg/kg-d	1.0E-05	mg/kg-d	1E-04
					Zinc	7E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								3E-10					1E-04
	Receptor Total											3E-10					5E-02
										Total of Receptor Risks Across All Media		8E-10	Total of Receptor Hazards Across All Receptors				1E-01

TABLE 7.3.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
CENTRAL TENDENCY
Cherokee County OU8 - Rail Lines

Scenario Timeframe:	Current/Future
Receptor Population:	Child
Receptor Age:	0-6 years

Medium	Receptor	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
						Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
								Value	Units	Value	Units		Value	Units	Value	Units	
Soil	High-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						6.1E-05	mg/kg-d	1.0E-03	mg/kg-d	6E-02
					Zinc	6E+03	mg/kg						8.2E-03	mg/kg-d	3.0E-01	mg/kg-d	3E-02
				Exp. Route Total													9E-02
				Dermal	Cadmium	5E+01	mg/kg						6.6E-08	mg/kg-d	2.5E-05	mg/kg-d	3E-03
					Zinc	6E+03	mg/kg										
				Exp. Route Total													3E-03
				Inhalation	Cadmium	5E+01	mg/kg	3.2E-08	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	6E-11	1.1E-09	mg/kg-d	1.0E-05	mg/kg-d	1E-04
					Zinc	6E+03	mg/kg										
				Exp. Route Total								6E-11					1E-04
	Receptor Total											6E-11					9E-02
Soil	Low-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						2.1E-05	mg/kg-d	1.0E-03	mg/kg-d	2E-02
					Zinc	7E+03	mg/kg						2.9E-03	mg/kg-d	3.0E-01	mg/kg-d	1E-02
				Exp. Route Total													3E-02
				Dermal	Cadmium	5E+01	mg/kg						2.2E-08	mg/kg-d	2.5E-05	mg/kg-d	9E-04
					Zinc	7E+03	mg/kg										
				Exp. Route Total													9E-04
				Inhalation	Cadmium	5E+01	mg/kg	1.1E-08	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	2E-11	3.8E-10	mg/kg-d	1.0E-05	mg/kg-d	4E-05
					Zinc	7E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								2E-11					4E-05
	Receptor Total											2E-11					3E-02
								Total of Receptor Risks Across All Media				8E-11	Total of Receptor Hazards Across All Receptors				1E-01

TABLE 7.3.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Cherokee County OU8 - Rail Lines

Scenario Timeframe:	Current/Future
Receptor Population:	Child
Receptor Age:	0-6 years

Medium	Receptor	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
						Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
								Value	Units	Value	Units		Value	Units	Value	Units	
Soil	High-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						2.0E-04	mg/kg-d	1.0E-03	mg/kg-d	2E-01
					Zinc	6E+03	mg/kg						2.7E-02	mg/kg-d	3.0E-01	mg/kg-d	9E-02
				Exp. Route Total													3E-01
				Dermal	Cadmium	5E+01	mg/kg						5.5E-07	mg/kg-d	2.5E-05	mg/kg-d	2E-02
					Zinc	6E+03	mg/kg										
				Exp. Route Total													2E-02
				Inhalation	Cadmium	5E+01	mg/kg	1.6E-07	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	3E-10	1.9E-09	mg/kg-d	1.0E-05	mg/kg-d	2E-04
					Zinc	6E+03	mg/kg										
				Exp. Route Total								3E-10					2E-04
	Receptor Total											3E-10					3E-01
Soil	Low-frequency recreational visitor	Surface Soil	Main Rail Lines	Ingestion	Cadmium	5E+01	mg/kg						1.2E-04	mg/kg-d	1.0E-03	mg/kg-d	1E-01
					Zinc	7E+03	mg/kg						1.8E-02	mg/kg-d	3.0E-01	mg/kg-d	6E-02
				Exp. Route Total													2E-01
				Dermal	Cadmium	5E+01	mg/kg						3.3E-07	mg/kg-d	2.5E-05	mg/kg-d	1E-02
					Zinc	7E+03	mg/kg										
				Exp. Route Total													1E-02
				Inhalation	Cadmium	5E+01	mg/kg	9.7E-08	mg/kg-d	1.8E-03	$(\mu g/m^3)^{-1}$	2E-10	1.1E-09	mg/kg-d	1.0E-05	mg/kg-d	1E-04
					Zinc	7E+03	mg/kg							mg/kg-d		mg/kg-d	
				Exp. Route Total								2E-10					1E-04
	Receptor Total											2E-10					2E-01
Total of Receptor Risks Across All Media												5E-10	Total of Receptor Hazards Across All Receptors				5E-01

APPENDIX K

STREAMLINED ECOLOGICAL RISK ASSESSMENT

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Streamlined Ecological Risk Assessment
Cherokee County Railroads Site Operable Unit Eight

6/24/2015

Environmental Assessment and Monitoring Branch
Environmental Services Division
USEPA Region 7

Streamlined Ecological Risk Assessment
Cherokee County Railroads Site
Operable Unit Eight

6/24/2015
Environmental Assessment and Monitoring Branch
Environmental Services Division
USEPA Region 7

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1.0. SITE BACKGROUND

The Cherokee County Superfund Site is part of the Tri-State Mining District, which covers approximately 2,500 square miles in northeast Oklahoma, southeast Kansas and southwest Missouri. The Cherokee County site includes 115 square miles in the Kansas portion of the TSMD (Figure 1).

Between 1850 and 1970, the TSMD produced 500 million tons of lead-zinc ore. The Cherokee County Superfund Site was placed on the National Priorities List in 1983. As listed, the site includes the following seven sub-sites: Galena, Baxter Springs, Treece, Badger, Lawton, Waco, and Crestline. These seven sub-sites encompass most of the area where mining occurred within the site and where physical surface disturbances were evident.

The site consists of mine tailings, soil, sediment, surface water, and groundwater contaminated with heavy metals (principally lead, zinc, and cadmium). The primary sources of contamination are residual metals in the abandoned mine workings, chat piles, and tailing impoundments in addition to historical impacts from smelting operations. During the years the mines operated, railroads were constructed in Cherokee County to join conventional large-scale railroads to the individual mining operations (Figure 2). Historically, the ballast used in the railroad beds was composed of chat from surrounding mine waste piles. Traditionally, these historical railroads were abandoned in place when mining operations ceased at a mine. Currently, the historical rail lines that cross through private property vary in condition from showing little degradation to being unidentifiable as former rail lines. Depending on the current use of the area, some former rail lines exhibit extensive vegetative re-growth with a thick organic layer, having been almost entirely incorporated into the surrounding area.

Numerous remedial and removal actions have taken place in several operable units, as noted in the Record of Decision and ROD amendments for the site. Several historical rail lines have been addressed during previous remedial actions on properties where they were encountered. Also, some lines may have been completely removed as a result of subsequent construction activities, such as highway cuts. However, Operable Unit Eight includes rail lines that are potentially contaminated, but have not been addressed under previous remedial activities. Because clean-up levels have been developed for Cherokee County (EPA, 2006) and the TSMD (MacDonald *et al*., 2010), this risk assessment employs a streamlined approach in which the terrestrial and aquatic exposure point concentrations are compared directly to existing clean-up levels. This is similar to the approach used in a screening level ecological risk assessment; however, the clean-up levels are based on site-specific data and exposure assumptions.

2.0. PREVIOUS ECOLOGICAL INVESTIGATIONS

Several studies have been published demonstrating the deleterious effects of mine waste on a number of ecological endpoints. This section provides a brief summary of ecological studies that have been completed to date.

2.1. TERRESTRIAL ENVIRONMENT

Bird toxicity from exposure to mine waste or mining-impacted media (water, sediment, etc.) has been confirmed in the TSMD. As early as 1923, deaths of mallards, pintails, and teal on the Spring River (near Riverton, KS), were reported (Phillips and Lincoln, 1930). The deaths were attributed to lead poisoning from sediments contaminated with mine waste. Sileo *et al.* (2003) diagnosed zinc poisoning in three Canada geese and one mallard collected in the TSMD. These four waterfowl had mild to severe degenerative abnormalities of the exocrine pancreas with zinc concentrations in the liver and pancreas consistent with tissue concentrations detected in waterfowl experimentally poisoned with zinc. The pancreatitis described has been widely used to diagnose zinc poisoning in pet or captive birds that have swallowed hardware or other items containing zinc (Droual *et al*., 1991; Zdziarski *et al*., 1994). Based on pancreatic lesions and increased tissue concentrations, Carpenter *et al*. (2004) diagnosed zinc poisoning in a trumpeter swan that had been observed on a TSMD mill pond for four weeks. This swan was weak, stumbled, and was taken to the College of Veterinary Medicine at Kansas State University. The bird was not rehabilitated and died within a day.

Beyer *et al*. (2005) evaluated the effects of metal contamination in wild birds from the TSMD. Waterfowl were the only birds from the TSMD that had significantly increased zinc concentrations in both livers and kidneys. Overall, the study found that the habitat in the TSMD is contaminated to the extent that zinc toxicosis in waterfowl may occur, but the route of exposure is uncertain Tissue concentrations of zinc were not elevated significantly in non-waterfowl species. However, tissue concentrations have been shown to be imperfect indicators of exposure in birds. For example, songbirds from a site severely contaminated with zinc from smelting had whole-body zinc concentrations that were increased only 20% compared with concentrations in songbirds from a reference site, although there was a >10-fold difference in soil zinc concentrations (Beyer *et al*., 1985). This is likely due to the fact that birds regulate zinc effectively within a wide range of exposure. Several of the non-waterfowl species from the study did however exhibit tissue concentrations of lead associated with impaired biological functions and external signs of poisoning.

In addition to documented cases of zinc poisoning in birds, zinc is known to be toxic to horses at high concentrations. Zinc toxicosis in horses from the TSMD has been reported for decades, with foals being particularly sensitive to the effects of elevated zinc in soil. The signs of zinc poisoning in foals are swelling at the epiphyseal region of long bones, joint cartilage lesions (osteochondrosis), lameness, walking on the tips of the hooves, and unthriftiness (Willoughby *et al*., 1972; Gunson *et al.*, 1982; Eamens *et al*., 1984; Kowalczyk *et al*., 1984). Although cadmium may have a role in causing injury (Gunson *et al*., 1982), the induction of the toxic signs through the experimental feeding of zinc oxide to foals (Willoughby *et al*., 1972) strongly suggests that zinc is the main cause of the toxicity. Signs of zinc poisoning in foals are distinct from those of lead poisoning, which is characterized by pharangeal and laryngeal paralysis (Willoughby *et al*., 1972). Toxic concentrations of zinc in foals induce copper deficiency (Eamens *et al*., 1984), and copper is required by the enzyme lysyl oxidase, which catalyzes the cross linking of cartilage and elastin. Weakened or thinner cartilage may become eroded in joints, leading to osteochondrosis. The critical time for a foal is when it is a few months old, has been weaned, is rapidly growing and is let out into pasture. Also, wildlife such as deer from the vicinity of zinc smelters have been found to exhibit similar joint lesions (Sileo and Beyer, 1985).

As part of the ecological risk assessment for the Cherokee County Site, EPA calculated high and low potential effects of zinc toxicity for foals in pastures (EPA, 2006). These potential effects were calculated based on two assumptions. First, the risks were modeled specifically for juveniles, which are more sensitive to zinc toxicity. Second, it was assumed that as vegetation becomes more stunted due to increasing soil zinc concentrations, horses would ingest increasing amounts of soil while attempting to forage for food. A soil concentration of 8,500 mg/kg was determined to be the zinc concentration at which a high potential for zinc toxicosis in horses exists. Whereas, a soil concentration of 1,000 mg/kg was determined to be the zinc concentration below which horses are unlikely to be affected by zinc.

In addition to calculating soil concentrations protective of horses, EPA ecologists developed preliminary remediation goals for metals-impacted soil for select terrestrial receptors at the site based on site-specific data. It was determined that ecological PRGs for soil ranged from 1.0 to 10.0 mg/kg for cadmium; 377 to 1,175 mg/kg for lead; and 156 to 1,076 mg/kg for zinc.

The RODs and ROD amendments for the Cherokee County sub-sites have outlined the remedial action objectives and associated clean-up levels for soil, sediment and surface water that are considered protective of the environment. Based on the PRGs proposed for the site, the following ecological clean-up levels were selected for soil (EPA, 2006):

- 10 mg/kg cadmium
- 400 mg/kg lead
- 1,100 mg/kg zinc

The clean-up levels for Cherokee County generally fall within the ranges of recently developed wildlife screening concentrations (Ford and Beyer, 2014). WSCs were developed to determine the need for risk assessment, remediation or changes in management practices on public lands impacted by mining. WSCs are meant to represent concentrations above which animals may exhibit impaired health from exposure to metals.

Table 1. Wildlife Soil Criteria (Ford and Beyer, 2014).

Wildlife Receptor	Cadmium (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
Deer Mouse	18	191	1437
Cottontail	25	262	1973
Bighorn	24	1224	1066
White-tailed Deer	15	1627	1238
Mule Deer	15	1650	1256
Elk	21	2339	1780
Mourning Dove	9	133	634
Mallard	25	637	1896
Canadian Goose	32	536	2393
Cattle	20	1127	1600
Sheep	23	1146	992
Horse	21	142	1674
Range WSC	9-32	133-2339	634-2393
Cherokee County Clean-up Level	10	400	1,100

2.2. AQUATIC ENVIRONMENT

The effects of metal contamination in the TSMD on aquatic life have also been documented. The Spring River and its tributaries represent the principal watershed in Cherokee County. An advanced screening level ecological risk assessment of the aquatic habitats within the TSMD (MacDonald *et al*., 2010) found moderate to high risks to the benthic community at several locations within the middle and lower Spring River, as well as on tributaries such as Cow Creek, Shawnee Creek, Willow Creek and Tar Creek.

Moreover, field studies on freshwater mussels native to Kansas (Angelo *et al*., 2007) indicate significant impacts to local mussel populations as a result of surficial mine waste washing into stream systems and impacting the surface water and sediments. Metals associated with the mining process have caused toxic effects in fish (Schmitt *et al*., 1993), and limited the population of the Neosho madtom (*Noturus placidus*), which is a federally listed fish species (Wildhaber *et al*., 2000).

Site-specific sediment clean-up levels were developed by MacDonald *et al*. (2010). The TSMD sediment clean-up levels are based on a 20% increase in toxicity to amphipods, midges and/or freshwater mussels relative to the mean for a reference sample. These response rates are referred to as T_{20} values. The T_{20} values are the basis for the following sediment clean-up levels:

- Cadmium – 17.3 mg/kg
- Lead –219 mg/kg
- Zinc – 2,949 mg/kg

3.0 PROBLEM FORMULATION

The problem formulation phase establishes the goals, breadth, and focus of the ecological risk assessment (EPA, 1997). This critical component of the process establishes the assessment endpoints, based on a well-defined site conceptual model (Figure 3). Defining the ecological problems to be addressed involves identifying toxic mechanisms of the contaminants of concern, characterizing potential receptors, estimating exposure and potential risks, as well as identifying the data quality objectives for the ecological risk assessment.

3.1. CONTAMINANTS OF CONCERN

Based on sampling events conducted during previous investigations, the primary contaminants of concern are cadmium, lead, and zinc. These contaminants are typically associated with mine wastes in the TSMD. Various other metals are often found at these mining sites; however, cadmium, lead, and zinc are considered the primary risk drivers. Toxicity assessments for the primary COCs can be found in Appendix A.

3.2. MIGRATION PATHWAYS

The sources of contamination for OU8 are the rail beds, which likely contain high metal concentrations in the chat material used to construct the ballasts. Based on the nature of the contamination in Cherokee County, and the physical characteristics of the site, potential routes of contaminant migration include the following:

- Chat on Ballast-to-Soil
- Soil-to-Surface Water/Sediment Migration
- Air-to-Soil Migration
- Biological/Food Chain Transfer

The following subsections present a discussion of each potential route of contaminant migration for the site.

3.2.1. Chat on Ballast-to-Soil Migration. Contamination on rail lines may be transported by the wind or surface water runoff and deposited in adjacent soil. The extent of contaminant migration from the Cherokee County rail lines to surrounding soil was evaluated by EPA (EPA, 2013). Ten rail bed locations were identified to study this potential migration pathway. Using an XRF instrument, lead concentrations in surface soil were measured along transects from the base (one or both sides) of each rail bed (Table 2). XRF measurements were taken at five meter intervals. The study found that lead concentrations declined to either background levels or below clean-up levels within 5 to 10 meters of the base. At many locations, the lead concentration at the base of the ballast did not exceed background or site-specific clean-up levels.

However, at one location (Location 2), lead concentrations remained significantly elevated at 40 meters from the base. At this particular location, the property owner had removed the material from the rail line and distributed over the property. The full extent of contamination on this property has not been fully assessed, as no further measurements were taken beyond 40 meters. However, based on the overall patterns documented in the field survey, EPA concluded that unless the ballast material has been manipulated, the extent of contamination off the rail bed due to wind and surface run-off is primarily confined to within 5 to 10 meters of the base. Although data for other metals is not available, it is assumed that other metals follow a similar pattern of dispersion.

Table 2. Measured Migration of Lead from the Base of the Rail Ballast

Location #1	Base 1	5 m	7 m	Base 2	1.5 m		
Concentration (mg/kg)	95	65	47	111	43		
Location #2	Base 1	5 m	40 m				
Concentration (mg/kg)	678	516	721				
Location #3	Base 1	5 m	15 m				
Concentration (mg/kg)	165	99	98				
Location #4	Base 1	5 m					
Concentration (mg/kg)	160	17					
Location #5	Base 1	5 m		Base 2	5 m		
Concentration (mg/kg)	49	NA		83	60		
Location #6	Base 1	5 m					
Concentration (mg/kg)	214	29					
Location #7	Base 1	5 m					
Concentration (mg/kg)	30	16					
Location #8	Base 1	5 m					
Concentration (mg/kg)	28	32					
Location #9	Base 1	5 m		Base 2	5 m		
Concentration (mg/kg)	92	44		79	49		
Location #10	Base 1	5 m		Base 2	5 m		
Concentration (mg/kg)	155	18		113	32		

In addition to the potential migration of contaminated material from rail beds to surrounding soil, the rail lines themselves deteriorate as vegetation begins to take hold. This successional process builds up the soil on the lines such that the metals are mixed with an organic soil layer.

3.2.2. Soil to Surface Water/Sediment Migration. Contaminants from rail beds may be transported by the wind or surface water runoff to the soil surrounding the rail lines, and deposited in down gradient floodplains, surface waters and/or settle in surface water bodies as sediment. This migration pathway is particularly relevant at rail bridge locations.

3.2.3. Soil to Air Migration. Fine-grained materials from source areas (particularly rail beds and rail cars) may be transported by the wind and released to the atmosphere. Constituents bound to surface soils may be transported as suspended particulates or dust to downwind locations. Factors influencing the potential for dust entrainment into the atmosphere include surface roughness, surface soil moisture, soil particle sizes, type and amount of vegetative cover, amount of soil surface exposed to the eroding wind force, physical and chemical properties of the soil, wind velocity, and other meteorological conditions.

3.2.4. Biological/Food Chain Migration. Biological migration may occur through uptake, bioaccumulation, and food-chain transfer.

3.3. ASSESSMENT ENDPOINTS

An assessment endpoint is "an explicit expression of the environmental value that is to be protected" (EPA, 1992). A measurement endpoint is defined as “a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint” and is a measure of biological effects (e.g., mortality, reproduction, growth) (EPA, 1992). Measurement endpoints are frequently numerical expressions of observations (e.g., toxicity test results, community diversity measures) that can be compared statistically to a control or reference site to detect adverse responses to a site contaminant.

The conceptual model establishes the complete exposure pathways that will be evaluated in the ERA and the relationship of the measurement endpoints to the assessment endpoints (Figure 3). The relationship of the selected measurement endpoint to the assessment endpoints are presented in Table 3. The site-specific assessment endpoints for OU8 are based on the assessment and measurement endpoints used to derive the clean-up levels already established in the ROD for Cherokee County. The assessment endpoint used to address terrestrial risk in the Cherokee County ROD includes protection of the growth, reproduction and survival of ground-feeding vermivores (the American woodcock and the short-tailed shrew). The assessment endpoint used to address aquatic risk includes protection of the growth and survival of benthic macroinvertebrate communities.

Table 3. Assessment Endpoints and Measures of Exposure and Effects.

Assessment Endpoint	Measures of Exposure/Effects
Survival, growth and reproduction of vermivore birds and mammals	Modeled exposure point concentrations were compared to toxicity reference values for survival, growth and reproduction of the short-tailed shrew and American woodcock (Appendix B).
Survival, growth and reproduction of benthic invertebrates	Survival and growth of the amphipod, *Hyalella azteca*, in 28-day sediment exposures. Survival and growth of the midge, *Chironomus dilutus*, in 10-day sediment exposures. Survival and growth of the freshwater mussel, *Lampsilis siliquoidea*, in 28-day sediment exposures (Appendix B).

3.3.1. Vermivore Communities. Food chain transfer of contaminants from terrestrial soil invertebrates to higher trophic level organisms is an important exposure pathway. Therefore, *survival, growth and reproduction of terrestrial vermivore communities* exposed to metals present in terrestrial invertebrate tissue is included as an assessment endpoint. The ecological clean-up levels established in the ROD are based on potential risk to the short-tailed shrew and American woodcock (Appendix B).

3.3.2. Benthic Macroinvertebrate Communities. Benthic invertebrate communities are directly exposed to sediment, surface water, and sediment pore water. They have been shown to be sensitive to metal contamination at the site. Therefore, *survival, growth and reproduction of benthic macroinvertebrate communities* exposed to metals in sediment and surface water is included as an assessment endpoint. The aquatic clean-up levels for sediment established in MacDonald *et al*. (2010) are based on potential risk to the benthic macroinvertebrate community (Appendix B).

4.0. SITE INVESTIGATION AND DATA ANALYSIS

The site investigation included the collection of data necessary to evaluate the exposure and effects of contaminants of concern on ecological assessment endpoints. Specific information pertaining to field sampling, including standard operating procedures and quality assurance and quality control can be found in the field sampling and quality assurance and quality control plans for this site (HGL, 2013; EPA, 2013). The following data has been collected and evaluated:

- Soil – The remedial investigation included surface and subsurface soil samples from 33 former rail line locations distributed throughout roughly 100 miles of Cherokee County (Figure 4). Soil samples were collected from the surface to a depth of 4 feet (in 6-inch intervals). Metal concentrations were analyzed using a combination of a portable XRF instrument and fixed-laboratory confirmation analyses (inductively coupled plasma atomic emission spectroscopy [ICP-AES]). ICP analysis is available for surface soil from nine of the 33 locations. For ecological risk assessment purposes, soil is generally collected at the 0-12 inch depth interval. Therefore, at all locations, results from the 0-6 inch and 6-12 inch depth intervals were used to estimate potential risk to terrestrial receptors.

To determine the best use of the mixed XRF and ICP data, a data adequacy review was conducted by SRC (2014) (Appendix C). The review found that the 2013 ICP soil data for cadmium, lead and zinc is adequate for use in the human health risk assessment. Additionally, the 2013 XRF soil data for lead and zinc were considered adequate for use in human health risk assessment. Further, SRC proposed that whenever ICP data are available at a sampling location, these data are preferred over XRF data from the same station, and only the ICP data would be included in the calculation of an exposure point concentration for that location. If only XRF data for lead or zinc are available for a sampling location, then the ICP-equivalent concentration estimated from XRF results are included in the calculation of EPCs. XRF data for cadmium were not recommended for use in risk assessment because XRF results for cadmium did not meet data adequacy criterion.

This ERA utilizes the approach recommended by SRC (2014) for the human health risk assessment. ICP data was used where available, and ICP-equivalent data was used to estimate concentrations for lead and zinc at the remaining locations. The ICP-equivalent concentration is based on the following formulas for the log-transformed XRF vs. ICP data (SRC, 2014):

- Lead: ICP-equivalent = 1.05 (XRF) – 0.131 (R^2 = 0.82)
- Zinc: ICP-equivalent = 0.986 (XRF) – 0.876 (R^2 = 0.88)

Soil samples were collected and analyzed at the center (sample identification letter A) of each rail line at all locations. Additionally, at several locations, the lateral extent of contamination was evaluated using XRF (or in some cases ICP) at locations radiating out from the center. The data adequacy review found statistically significant differences for center versus lateral samples. However, in an effort to use the ICP data that is available for the site, lateral locations in which ICP data is available were used to estimate an EPC, even if ICP data for the center was not available. At some locations, ICP data is available for the center location as well as a lateral location. In those cases, the EPC is based on the center location. For locations with only XRF data (ICP-equivalent), the center location was used to calculate the EPC.

Finally, the data adequacy review evaluated trends in contaminant concentrations in surface (0-6 inches) versus subsurface (>6 inches) soils. Based on the results of a

Wilcoxon Rank Sum test, no statistically significant difference ($p>0.05$) between surface and subsurface soils was found. On that basis, there are no discernable vertical/depth trends, indicating that soil data can be combined across depth intervals. Therefore, the ICP data from either a 0-6 inch interval or 6-12 inch interval was used to estimate the EPC, based on the assumption that either depth range would be a relatively good estimate of the concentration for the 0-12 inch depth interval. Because ICP-equivalent concentrations can be calculated for both depth intervals, EPCs are based on the mean of the 0-6 inch and 6-12 inch concentrations.

- Surface Water and Sediment – Nine surface water and sediment samples have been collected at locations adjacent to abandoned rail line bridges (Figure 5). Surface water samples were analyzed for dissolved metals and hardness. Bulk sediment was analyzed for total metals.

4.1. DATA ANALYSIS

This ERA utilizes a streamlined approach to evaluate soil, sediment and surface water data. The ecological clean-up levels for soil have already been established in the Record of Decision for Cherokee County (OU3 and OU4) (EPA, 2006). The clean-up levels for sediment are based on the values established for the Tri-State Mining District (MacDonald *et al*., 2010). Finally, surface water clean-up levels are based on chronic National Ambient Water Quality Criteria, and are adjusted based on site specific hardness. Based on the assessment endpoints selected for the development of the Cherokee County clean-up levels, each of the 33 rail bed locations and nine stream location are considered separate exposure areas.

5.0. STREAMLINED RISK CHARACTERIZATION

Because clean-up levels have already been developed for Cherokee County, a streamlined approach was used to characterize ecological risk in which exposure point concentrations are compared directly to clean-up levels. This is similar to the approach used in a SLERA; however, clean-up levels are based on site-specific data and exposure assumptions. Risk characterization results can be found in Tables 4-7.

Table 4. Concentrations of Cadmium, Lead and Zinc in Surface Soil Compared to Clean-Up Levels.

Location	EPC Method	Depth Interval (inches)	Cadmium (mg/kg)	Cadmium Exceeds Clean-up Level	Lead (mg/kg)	Lead Exceeds Clean-up Level	Zinc (mg/kg)	Zinc Exceeds Clean-up Level
CCR-SS-1A	ICP	0-6	42.6	Yes	490	Yes	9870	Yes
CCR-SS-2A	ICP	6-12	84.6	Yes	1940	Yes	16200	Yes
CCR-SS-3A	ICP	6-12	29.2	Yes	417	Yes	4500	Yes
CCR-SS-4A	ICP-equivalent	0-6	NA	NA	852.0	Yes	8718.2	Yes
CCR-SS-4A	ICP-equivalent	6-12	NA	NA	512.9	Yes	10137.3	Yes
CCR-SS-4 (mean)	ICP-equivalent	0-12	NA	NA	682.5	Yes	9427.8	Yes
CCR-SS-5BN	ICP	6-12	24.1	Yes	3260	Yes	7170	Yes
CCR-SS-6A	ICP	6-12	24.3	Yes	322	No	6080	Yes
CCR-SS-7B	ICP	6-12	40.3	Yes	270	No	9610	Yes
CCR-SS-8B	ICP	6-12	79.3	Yes	906	Yes	16800	Yes
CCR-SS-9A	ICP	0-6	48.2	Yes	369	No	11900	Yes
CCR-SS-10A	ICP	0-6	38.6	Yes	398	No	8190	Yes
CCR-SS-11A	ICP	0-6	38.8	Yes	827	Yes	12600	Yes
CCR-SS-12B	ICP	0-6	45.1	Yes	457	Yes	12000	Yes
CCR-SS-13A	ICP	6-12	46.5	Yes	820	Yes	9420	Yes
CCR-SS-14A	ICP-equivalent	0-6	NA	NA	114.7	No	7794.5	Yes
CCR-SS-14A	ICP-	6-12	NA	NA	152.9	No	4984.5	Yes

	equivalent							
CCR-SS-14(mean)	ICP-equivalent	0-12	NA	NA	133.8	No	6389.5	Yes
CCR-SS-15A	ICP	0-6	16.4	Yes	461	Yes	2330	Yes
CCR-SS-16A	ICP	0-6	16.8	Yes	528	Yes	2530	Yes
CCR-SS-17A	ICP-equivalent	0-6	NA	NA	686.3	Yes	9265.8	Yes
CCR-SS-17A	ICP-equivalent	6-12	NA	NA	552.5	Yes	28786.5	Yes
CCR-SS-17(mean)	ICP-equivalent	0-12	NA	NA	619.4	Yes	19026.2	Yes
CCR-SS-18A	ICP-equivalent	0-6	NA	NA	499.6	Yes	18424.0	Yes
CCR-SS-18A	ICP-equivalent	6-12	NA	NA	326.8	No	34809.3	Yes
CCR-SS-18(mean)	ICP-equivalent	0-12	NA	NA	413.2	Yes	26616.7	Yes
CCR-SS-19A	ICP-equivalent	0-6	NA	NA	1342.5	Yes	1187.5	Yes
CCR-SS-19A	ICP-equivalent	6-12	NA	NA	284.2	No	1395.2	Yes
CCR-SS-19(mean)	ICP-equivalent	0-12	NA	NA	813.4	Yes	1291.4	Yes
CCR-SS-20A	ICP-equivalent	0-6	NA	NA	14.0	No	300.8	No
CCR-SS-20A	ICP-	6-12	NA	NA	14.0	No	310.1	No

	equivalent							
CCR-SS-20(mean)	ICP-equivalent	0-12	NA	NA	14.0	No	305.5	No
CCR-SS-21C	ICP	6-12	12.9	Yes	916	Yes	3470	Yes
CCR-SS-22A	ICP-equivalent	0-6	NA	NA	872.1	Yes	5322.4	Yes
CCR-SS-22A	ICP-equivalent	6-12	NA	NA	860.6	Yes	4847.9	Yes
CCR-SS-22(mean)	ICP-equivalent	0-12	NA	NA	866.4	Yes	5085.2	Yes
CCR-SS-23A	ICP-equivalent	0-6	NA	NA	361.0	No	11055.3	Yes
CCR-SS-23A	ICP-equivalent	6-12	NA	NA	302.4	No	9269.6	Yes
CCR-SS-23(mean)	ICP-equivalent	0-12	NA	NA	331.7	No	10162.5	Yes
CCR-SS-24A	ICP	6-12	36.5	Yes	609	Yes	6640	Yes
CCR-SS-25A	ICP	6-12	49.2	Yes	1960	Yes	14100	Yes
CCR-SS-26A	ICP	0-6	37.2	Yes	884	Yes	8100	Yes
CCR-SS-27A	ICP	6-12	54.5	Yes	4200	Yes	12100	Yes
CCR-SS-28A	ICP	6-12	69.8	Yes	466	Yes	12500	Yes
CCR-SS-29A	ICP-equivalent	0-6	NA	NA	216.3	No	29492.2	Yes
CCR-SS-29A	ICP-equivalent	6-12	NA	NA	224.7	No	24420.4	Yes
CCR-SS-29(mean)	ICP-	0-12	NA	NA	220.5	No	26956.3	Yes

	equivalent							
CCR-SS-30A	ICP-equivalent	0-6	NA	NA	456.1	Yes	7441.8	Yes
CCR-SS-30A	ICP-equivalent	6-12	NA	NA	792.5	Yes	16113.8	Yes
CCR-SS-30(mean)	ICP-equivalent	0-12	NA	NA	624.3	Yes	11777.8	Yes
CCR-SS-31A	ICP-equivalent	0-6	NA	NA	531.2	Yes	8778.7	Yes
CCR-SS-31A	ICP-equivalent	6-12	NA	NA	552.0	Yes	9237.2	Yes
CCR-SS-31A(mean)	ICP-equivalent	0-12	NA	NA	541.6	Yes	9008	Yes
CCR-SS-32A	ICP-equivalent	0-6	NA	NA	840.1	Yes	20983.7	Yes
CCR-SS-32A	ICP-equivalent	6-12	NA	NA	798.4	Yes	10662.4	Yes
CCR-SS-32(mean)	ICP-equivalent	0-12	NA	NA	819.3	Yes	15823.01	Yes
CCR-SS-33A	ICP	6-12	60	Yes	727	Yes	11600	Yes

Soil clean-up levels for Cherokee County are 10 mg/kg for cadmium, 400 mg/kg for lead, and 1,100 mg/kg for zinc.

Table 5. Concentrations of Cadmium, Lead and Zinc in Sediment Compared to Clean-up Levels.

Location	Cadmium (mg/kg)	Cadmium Exceeds Clean-up Level	Lead (mg/kg)	Lead Exceeds Clean-up Level	Zinc (mg/kg)	Zinc Exceeds Clean-up Level
CCR-SD01	6.9	No	46.6	No	205	No
CCR-SD02	6.4	No	78.5	No	1940	No
CCR-SD03	20.9	Yes	152	No	4010	Yes
CCR-SD04	3.5	No	39.3	No	299	No
CCR-SD05	5.4	No	74.8	No	761	No
CCR-SD06	3.3	No	41.4	No	226	No
CCR-SD07	7.9	No	56.4	No	258	No
CCR-SD08	1.3U	No	49.1	No	117	No
CCR-SD09	1.5	No	22.9	No	95.9	No

Sediment clean-up levels are 17.3 mg/kg for cadmium; 219 mg/kg for lead, and 2,949 mg/kg for zinc (MacDonald *et al*., 2010).

Table 6. Concentrations of Cadmium, Lead and Zinc in Surface Water compared to Clean-Up Levels.

Location	Hardness	Cadmium (µg/L)	WQC (µg/L)	Cadmium Exceeds Criteria	Lead (µg/L)	WQC (µg/L)	Lead Exceeds Criteria	Zinc (µg/L)	WQC (µg/L)	Zinc Exceeds Criteria
CCR-SW01	150	0.12U	0.3	No	1.0U	3.9	No	20.4	111.1	No
CCR-SW02	500	0.12U	0.8	No	1.0U	13.7	No	1130	308	Yes
CCR-SW03	249	0.12U	0.5	No	1.0U	6.7	No	402	170.7	Yes
CCR-SW04	88.4	0.231	0.2	Yes	1.0U	2.2	No	55	71	No
CCR-SW05	114	0.12U	0.3	No	1.0U	2.9	No	39.6	88.1	No
CCR-SW06	415	0.12U	0.7	No	1.0U	11.4	No	26.1	263.1	No
CCR-SW07	136	0.12U	0.3	No	1.0U	3.5	No	24.6	102.3	No
CCR-SW08	207	0.137	0.4	No	1.0U	5.5	No	37	146	No
CCR-SW09	226	0.13	0.4	No	1.0U	6.04	No	26.2	157.2	No

Surface water clean-up levels are based on chronic NAWQC, and are adjusted based on site-specific hardness measurements.

6.0. RISK SUMMARY AND DISCUSSION

This section provides a more detailed discussion of the results from the comparison of detected concentrations to clean-up levels and NAWQC. Zinc and cadmium contamination is widespread on the rail lines. Cadmium concentrations are elevated above clean-up levels at every location evaluated, based on ICP data. Zinc concentrations are elevated at every location, except for Location 20. Lead contamination on the rail lines is slightly less widespread, with eight locations not exceeding the soil clean-up level.

The aquatic data indicate relatively low levels of surface water and sediment contamination where rail lines cross water bodies. Sediment concentrations of cadmium and zinc exceed clean-up levels at one location, SD03. Likewise, zinc concentrations in surface water are above NAWQC at SW03. This particular location is adjacent to the Spring River within the city of Baxter Springs. The closest rail line sample is Location 20, which was the only rail line location that did not exceed terrestrial clean-up levels for any contaminant. Therefore, the sediment/surface water contamination at SD03/SW03 may not be attributable to the rail line. The SLERA for aquatic habitats in the TSMD (MacDonald *et al*., 2010) found high risks to the benthic community in the Spring River above the tributary; however, only moderate risks to the benthic community in the Spring River were found adjacent to the tributary. Therefore, the Spring River may be influencing metal concentrations to some degree. There may also be groundwater-to-surface water interactions at this location, which may cause elevated zinc concentrations. Finally, there may be impacts from other unkown sources.

Zinc also exceeds NAWQC at SW02, which is within the city of Baxter Springs, just downstream from rail line locations 32 and 33. Extremely high concentrations of zinc were found at these rail line locations. Therefore, the contamination in Willow Creek (SW02) may be due to the rail line. Also, the TSMD SLERA found high risk to the benthic community at the confluence of the Spring River and Willow Creek, which is directly downstream of SW02.

Finally, cadmium exceeds NAWQC at Location 4. Location 4 is located in the headwaters of Tar Creek, where the stream is ephemeral. The hardness at Location 4 is quite low compared to the rest of the locations. This low hardness value reduced the criteria value for cadmium, resulting in Location 4 exceeding clean-up levels even though the cadmium concentration is only slightly above detection limits.

7.0 UNCERTAINTIES

There are inherent uncertainties in the risk assessment process; however, knowledge of the cause and potential effects of these uncertainties permits the risk assessor and risk manager to interpret and use the risk assessment in making site management decisions. Sources of uncertainty fall into several categories including analytical and sampling design, assumptions, natural variability, error, and insufficient knowledge. Risk assessment is essentially the integration of the exposure and hazard assessments. Sources of uncertainty associated with either of these elements may contribute to overall uncertainty. In addition, the risk assessment procedure itself can contribute to overall uncertainty. Each of these sources of uncertainty can be addressed differently; therefore, understanding how each of these sources of uncertainty is handled within the risk assessment is integral to the overall interpretation.

7.1. ANALYTICAL DATA

The analytical database has inherent uncertainties. For example, the contribution of the chemical of potential concern across the site was assumed to coincide with receptor contact with environmental media. The degree to which this assumption is met is not quantifiable and direction of bias cannot be measured. Also, there are relatively long stretches of rail line (15-20 miles) that are characterized by only one sample (or two samples close together). The assumption that contamination is uniform between sample locations is an uncertainty, with the uncertainty increasing relative to the distances between sampling locations.

7.2. UNCERTAINTY OF SCREENING CONTAMINANTS OF CONCERN

Although not primary risk drivers, other metals would likely be detected in the rail line soil samples. The extent of contamination due to other metals is unknown, as they were not evaluated by XRF or ICP. These metals were screened from the risk assessment based on management decisions related to the site history and not quantitative analyses. As a result, actual site risks were likely underestimated in some locations. Several of the additional metals have different mechanisms of toxicity that could change risk conclusions.

Also, there known synergistic and antagonistic relationships between metals which could affect fate, transport, and ecotoxicity. There is currently no way to quantify those relationships or how they impact the overall toxicity of metals to receptors at the site.

7.3. UNCERTAINTY OF THE CONCEPTUAL MODEL.

Organisms use their environment unevenly, and differential habitat use based on habitat quality is a source of uncertainty. Natural variability is an inherent characteristic of ecological systems, and there is a limit to our understanding of the population dynamics of most species, and the community interactions that exist between species. The complexity of ecological systems must be considered when interpreting the results of measurement endpoints as they relate to the assessment endpoint being evaluated.

At this site in particular, there is a great deal of variability in the condition of the former rail lines. Lines with an established plant community, which have become incorporated into the surrounding environment, provide better habitat than lines that remain elevated above the surrounding environment and have little established vegetation.

Also, the exposure model is based on the “average” behavior of a species. As such, extremes of behavior are not incorporated into the overall exposure assessment. While these assumptions may not apply to all individuals, they are generally applicable at the population level. While not all of the biological variability is captured in the assessment, no directional bias is introduced.

Finally, an additional source of uncertainty is the exclusion of the air pathway due not only to lack of data, but also due to the lack of physiological and toxicological data necessary to evaluate this exposure pathway. While this may not generate significant amounts of additional COC exposure, it may be a contributor to overall risks.

7.4. UNCERTAINTIES ASSOCIATED WITH TOXICOLOGICAL STUDIES

7.4.1. Variable Toxicity in the Aquatic Environment. There are specific uncertainties related to toxicity of contaminants in the aquatic environment. Temporal variations and variations related to climatic conditions can significantly increase or decrease the toxicity of metals. These variations may affect the concentration of individual metals, other essential nutrients, and hardness, which in turn affects metal toxicity and bioavailability.

7.4.2. Extrapolation of Laboratory Toxicity Tests to Natural Conditions. The toxicological data that were used to evaluate the implications of estimated doses of metals to receptors of concern constitute a source of uncertainty in the assessment. For example, organisms used in toxicity tests conducted in laboratories are not necessarily subjected to the same degree of non-toxicant related stress as receptors under natural conditions. In general, laboratory toxicity tests use single toxicants while receptors in the field are exposed to multiple toxicants. Multiple toxicants can behave indpendently (such as when modes of action are very different), they may act additively (or synergistically), such that expression of effects is driven by several toxicants simultaneously, or they may interact antagonistically. Cumulative effects of multiple stressors are not necessarily the same. It is difficult to predict the direction of bias in this case as laboratory conditions and natural conditions each may stress organisms but the relative magnitude and physiological implications of these stresses are not actually comparable. Also, due to the differences in the health of laboratory and field populations, differences in genetic diversity (and hence resistance to stressors), and possible impacts of non-toxicant stressors, some unavoidable uncertainty exists when extrapolating laboratory derived data to field situations. Given these factors, the difference between conducting laboratory tests with single stressors as compared to natural conditions with multiple stressors adds to the uncertainty regarding the conclusions of this risk assessment. In addition, although it is believed that the important potential sources of toxicity have been addressed, it is possible that there are unmeasured or unconsidered stressors at the site.

7.4.3. Differences between Responses of Test Species and Receptor Species. Toxicological studies also use species that, while they may be related to the taxa being evaluated at the site, are rarely identical. In general, the greater the taxonomic difference, the greater the uncertainty associated with the application of study data to the receptors of potential concern.

7.4.4. Differences in Chemical Forms of Contaminants. Many toxicological studies use chemical formulations and/or administration methods that do not relate well to field exposures. For example, many of the lead toxicology studies cited use lead acetate for exposures because it is known that this is one of the most bioavailable forms of lead. Lead in the environment at the site may not have similar bioavailability. The Cherokee County ecological clean-up levels account for some of this uncertainty, as they are calculated based on an estimated relative bioavailability of 40% (Beyer *et al*., unpublished).

7.4.5. Variability in Toxicity Reference Values. In some cases there may be a significant difference between the no effect and lowest effect level toxicity reference values used to estimate risk to a receptor. The actual point at which effects are seen could be anywhere in the range between these two values. The greater the range between the two values, the greater the uncertainty associated with the conclusions.

7.4.6. Extrapolation of Individual-Level Effects to Population-Level Effects. Laboratory based bioassays or toxicity tests measure the response of a laboratory "population" of organisms to the stressor under consideration. These populations generally represent a low diversity genetic stock and, as such, probably do not represent the range of sensitivities and tolerances characteristic of natural populations. As such, there is uncertainty associated with extrapolation of laboratory population responses to populations in natural systems. This uncertainty is probably not directionally biased as both sensitive and tolerant individuals may be missing from the laboratory populations.

7.5. UNCERTAINTIES ASSOCIATED WITH THE EXPOSURE ASSESSMENT

Exposure calculations used in deriving clean-up levels were based on feeding rates assumed to not vary with season, breeding condition, or with other local factors. Reported feeding rates undoubtedly vary with all of these factors because metabolic needs change as does food availability. The feeding rates were derived from studies that reported for multiple seasons. Overall, conservative upper-end estimates of feeding rates were used, potentially over-estimating risk.

Further, dietary compositions were assumed to not vary with season or local conditions. As with feeding rates, this assumption is unlikely to be met. Also, in some cases, dietary compositions were simplified due to lack of data. The assumption that the woodcock diet is composed of 100% earthworms may also slightly over-estimate potential risk.

Finally, there is significant uncertainty associated with applying an area use factor of 100% to OU8. The clean-up levels in the ROD for Cherokee County are based on this assumption; however, rail line contamination is not homogenous throughout a receptor's home range. Assuming 100% area use over-estimates potential risk due to the rail lines, as any one rail line would only constitute a small fraction of the receptor's home range. Therefore, it may be useful to estimate rail line specific clean-up levels based on slightly different exposure assumptions.

Prior to adjusting clean-up levels for the rail lines, it was determined that a simplified approach could be taken by focusing on zinc and lead. Although cadmium concentrations were elevated at every rail line location, zinc appears to diminish the toxicity of cadmium. The mechanisms of zinc protection against cadmium toxicity have been variously attributed to metallothionein induction, enhanced detoxification rates of cadmium, and competition with cadmium for the same metalloenzyme sites. Thus, high concentrations of zinc may interfere with the absorption of cadmium, and the high zinc-to-cadmium ratio (approximately 150 to 1) along with the close correlation between these two elements probably protects terrestrial food chains somewhat from cadmium toxicity (Chaney *et al*., 2001). Regardless of the mechanism, this phenomenon has been noted by several researchers (Eisler, 1993; Fox et al., 1983; Kowalczyk *et al*., 1984). More importantly, zinc toxicosis, (resulting in reduced survival) has been documented in both birds and mammals in the TSMD. Lead poisoning has also been documented in waterfowl, and elevated tissue concentrations of lead have been confirmed in wild birds (Beyer *et al*., 2004).

There are two ways to adjust the zinc and lead clean-up levels based on a rail line specific exposure scenario. The dose could be adjusted by reducing the area use factor (as a percentage of home range). However, given the small percentage of home range comprised of rail line, this adjustment results in extremely high concentrations that may be above acutely toxic levels. An alternative approach is to select toxicity reference values that would represent a short-term acute exposure. Although the TRV is based on acute effects, the limited area represented by rail lines is assumed to result in exposures that are even shorter in duration than the exposures used to estimate the acute TRVs. This should be protective of sensitive species foraging on the rail line for a short period of time. Moreover, for zinc in particular, organisms should be able to recover from limited high exposure levels due to the physiological ability to regulate zinc.

For mammals, an acute TRV for zinc is based on a study by Domingo *et al.* (1988) in which LD_{50} values in male Sprague Dawley rats and male Swiss mice after oral administration of zinc sulphate were calculated. After a preliminary screening with small groups of 3 animals of each species, ten animals in each group were used and observed for 14 days. Death occurred within the first 48 hours. Toxicity signs included conjunctivitis, decreased food and water consumption and hemorrhages and hematomas in the tail. Oral LD_{50} values for mice and rats were 926 mg/kg bw and 1,710 mg/kg bw, respectively. Applying the LD_{50} value for mice from this study to the model used to calculate the Cherokee County clean-up levels for the shrew (assuming an "acute" exposure to soil via earthworms and incidental soil ingestion), a rail line clean-up level of 6,200 mg/kg zinc was calculated (Table 7). The lead TRV for mammals is based on a shrew specific study (Pankakoski *et al*., 1994) in which effects on survival were noted after 31 days at a dose of 61.5 mg/kg bw. Based on this TRV, the resulting clean-up level for mammals is 1,770 mg/kg (Table 7). All of the assumptions for the shrew that were used to calculate the Cherokee County clean-up levels were retained, only the TRV was changed.

Similarly, an acute avian TRV for zinc is based on a study in ducks (*Anas* sp.) in which reduced survival was found following a one-time dose of zinc metal shot equivalent to 742 mg/kg bw (Eisler, 2000). The TRV for lead is based on a study by Kahn *et al*. (1993) in which effects on survival were noted in juvenile chickens after exposure for 7 days at a dose of 400 mg/kg bw/day. By applying these TRVs to the avian receptor (the American woodcock), and assuming an exposure scenario in which a woodcock consumes a single dose of zinc or lead via earthworms foraged from a rail line (with incidental soil), a rail line specific clean-up level of 4,000 mg/kg zinc and 7,800 mg/kg lead were calculated for birds (Table 8).

Between the values for birds and mammals, the lower (more protective) value should be used. Based on this approach, the zinc clean-up level for birds should be applied (4,000 mg/kg) and the lead clean-up level for mammals should be applied (1,770 mg/kg).

Table 7. Calculation of Rail Line Specific Clean-Up Levels for Lead.

Receptor	FIR (mg/kg bw/day)	Soil Ingestion as Proportion of diet	C_{plants} (mg/kg/dw)	C_{worm} (mg/kg/dw)	$C_{small\ mammal}$ (mg/kg/dw)	TRV (mg/kg bw/day)	Clean-up Level
Shrew	0.209	0.03	17.6	778.8	29.4	61.5	1,770
Woodcock	0.214	0.164	NA	3432	NA	400	7,800

C_{plants} was estimated using the equation ln(plants) = 0.561*ln(soil) - 1.328 (EPA, 2005)
C_{worm} was estimated using a site-specific soil-to-worm bioconcentration factor of 0.44 (Fitzpatrick *et al*., 1998)
$C_{small\ mammal}$ was estimated using the equation In(small mammal) = 0.4422*ln(soil) + 0.0761 (EPA, 2005)
Dose adjusted based on a relative bioavailability of 0.40 (Beyer *et al*., unpublished).
The shrew's diet is assumed to be 3% small mammal, 10% vegetation and 87% earthworm.
The woodcock's diet is assumed to be 100% earthworm.

Table 8. Calculation of Rail Line Specific Clean-Up Levels for Zinc.

Receptor	FIR (mg/kg bw/day)	Soil Ingestion as Proportion of diet	C_{plants} (mg/kg/dw)	C_{worm} (mg/kg/dw)	$C_{small\ mammal}$ (mg/kg/dw)	TRV (mg/kg bw/day)	Clean-up Level
Shrew	0.209	0.03	620.4	10,478	145.8	926	6,200
Woodcock	0.214	0.164	NA	6,760	NA	742	4,000

C_{plants} was estimated using the equation ln(plants) = 0.554*ln(soil) + 1.575 (EPA, 2007)
C_{worm} was estimated using site-specific soil-to-worm bioconcentration factor of 1.69 (Fitzpatrick *et al*., 1998)
$C_{small\ mammal}$ was estimated using the equation ln(small mammal) = 0.0706*ln(soil) + 4.3632 (EPA, 2007)
Dose adjusted based on a relative bioavailability of 0.47 (Roussel, 2009).
The shrew's diet is assumed to be 3% small mammal, 10% vegetation and 87% earthworm.
The woodcock's diet is assumed to be 100% earthworm.

Other wildlife receptors are exposed to zinc on rail lines, including mourning doves, white-tailed deer, turkey, prairie voles and deer mice. However, as the dose to vermivores includes higher incidental soil ingestion rates compared to herbivores/carnivores, the clean-up levels for the vermivores are generally protective of other wildlife species.

It should be noted that higher lead and zinc clean-up levels for the rail lines may not be protective of receptors that are directly exposed to contamination, such as the plant and soil invertebrate community. Stroh *et al*. (2009) calculated the concentrations of lead and zinc at which decreases in floristic quality could be identified. The proposed rail line clean-up level of 4,000 mg/kg for zinc is well above the zinc concentration in which a 20% decline in floristic quality was identified (2,515 mg/kg). At high levels of zinc in soil, a plant community may become established; however, it will be less diverse as sensitive species are eliminated. The soil invertebrate community would be similarly affected. Although earthworms from Jasper County have been found in areas with lead and zinc concentrations far exceeding sub-lethal and lethal TRVs for soil invertebrates (Fitzpatrick *et al*., 1998), the overall abundance is low. Further, many of the worms collected from affected areas in Jasper County had total zinc concentrations over 5,000 mg/kg, which establishes the fact that the earthworm exposure pathway can be significant.

Based on the rail line specific exposure assumptions, the following locations would not exceed a revised clean-up levels:

- 15
- 16
- 19
- 20
- 21

8.0 SUMMARY AND RECOMMENDATIONS

Zinc and cadmium contamination is widespread on the rail lines. Cadmium concentrations are elevated above clean-up levels at every location evaluated using ICP data. Zinc concentrations are elevated at every location, except for Location 20. Lead contamination on the rail lines is slightly less widespread, with eight locations not exceeding the clean-up level. Potential effects on the aquatic community were identified at three locations, with one location (SD02/SW02) where zinc from the rail line may be the primary cause of contamination. The other locations do not appear to be contaminated directly by the rail lines.

Clean-up levels for lead and zinc were also developed to account for the limited wildlife exposure due to rail line contamination. These clean-up levels are based on the same terrestrial assessment endpoint and corresponding exposure assumptions for vermivore receptors used to calculate the Cherokee County ecological clean-up levels. However, the TRV accounts for a short-term (acute) exposure scenario. These rail line specific clean-up levels include 1,770 mg/kg for lead and 4,000 mg/kg for zinc. The higher clean-up levels for rail lines result in an additional 4 locations that do not exceed clean-up levels. Therefore, the higher levels do not have a significant effect on any potential remediation at OU8. Further, these clean-up levels would only be applicable to rail lines that have not been disturbed by land owners and are not surrounded by other mining related impacts. Only in these cases would the limited exposure assumptions apply.

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APPENDIX A
TOXICITY PROFILES

CADMIUM

Cadmium is a naturally occurring element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). It does not have a definite taste or odor. All soils and rocks, including coal and mineral fertilizers, have some cadmium in them. Cadmium is often extracted during the production of other metals such as zinc, lead, and copper.

Orally ingested cadmium and its salts are poorly absorbed by the gastrointestinal tract in wildlife. In general, less than three percent of ingested cadmium is absorbed by the gastrointestinal tract of animals. Once in the blood, cadmium is distributed to all internal organs with the highest concentrations found in the liver and kidneys. Cadmium is not known to undergo metabolic conversion; however, it does bind with, and adversely affect the function of proteins such as metallothionein. Most cadmium ingested is rapidly cleared from the body, primarily through feces because its absorption efficiency is so low (ATSDR, 1993).

There is strong evidence for food chain bioaccumulation; however, the potential for biomagnification is presently unknown (ATSDR, 1993). EPA (2000) considers cadmium to be an important bioaccumulative compound in sediment.

- A soil-to-invertebrate Bioconcentration Factor (BCF) of 0.96 has been developed for cadmium based on the geometric mean of 22 laboratory studies using acute and chronic exposure (EPA, 1999).
- A soil-to-plant BCF of 0.364 has been developed for cadmium based on empirical data from the EPA (EPA, 1999).
- A water-to-invertebrate BCF of 3,461 has been developed for cadmium based on the geometric mean of data from eight field studies (EPA, 1999).
- A water-to-fish BCF of 907 has been developed for cadmium based on the geometric mean of data from four field studies (EPA, 1999).
- A sediment-to-invertebrate BCF of 3.4 has been developed for cadmium based on the geometric mean of data from eight field studies (EPA, 1999).

1.0. AQUATIC PLANTS

Cadmium is not essential for plant growth. Exposure to cadmium can result in adverse growth effects. The lowest chronic value of 2.0 µg/L was established for aquatic plants by Conway (1977). A relatively low cadmium concentration reduced the population growth rate of *Asterionella formosa* by an order of magnitude.

2.0. AQUATIC INVERTEBRATES

A lowest chronic value of 0.15 µg/L was established for daphnids as a result of life-cycle tests performed by Chapman *et al.* (no date). A test EC20 value of 0.75 µg/L was established for daphnids by Elnabarawy *et al*. (1986).

A substantial toxicological database for effects on freshwater biota exposed to cadmium demonstrates that ambient cadmium concentrations in water exceeding 10 ppb are associated with high mortality, reduced growth, inhibited reproduction, and other adverse effects. Several species of freshwater aquatic insects, crustaceans, and teleosts exhibited significant mortality at cadmium concentrations of 0.8 to 9.9 ppb during exposures of 4 to 33 days; mortality generally increased as exposure time increased, water hardness decreased, and organism age decreased. A Threshold Effect Concentration (TEC) for sediment of 0.99 mg/kg has been developed by MacDonald *et al.* (2000); whereas a Probable Effect Concentration (PEC) has been established at 4.98 mg/kg.

3.0. FISH

A lowest chronic value of 1.7 µg/L was established for fish by Sauter *et al*. (1976) and was based on early life stage tests performed on brook trout. A test EC20 value of 1.8 µg/L was established by Carlson *et al.* (1982) based on freshwater fish studies.

4.0. TERRESTRIAL PLANTS

Exposure to cadmium at relatively low levels can result in adverse growth effects. If present in a bioavailable form, cadmium can be taken up by roots, translocated within the plant, and accumulated (Efroymson *et al*., 1997a). Cadmium is chemically similar to zinc, an essential element. Competition between the two for organic ligands and enzyme binding sites may explain some of the toxic effects of cadmium and the ameliorative effects of zinc on cadmium toxicity. Cadmium depresses uptake of Fe, Mn, and probably Ca, Mg, and N. Cadmium is toxic at low concentrations. Symptoms resemble Fe chlorosis and include necrosis, wilting, reduced zinc levels, and reduction in growth. The mechanisms of toxicity include reduced photosynthetic rate, poor root system development, reduced conductivity of stems, and ion interactions in the plant. A benchmark value of 4 ppm was established for cadmium based on 74 studies. Approximately 40% of the concentrations responsible for greater than 20% reductions in plant growth parameters fall between 1 and 10 ppm cadmium added to soil. This range includes wild and cultivated plants such as legumes, trees, grasses, leafy vegetables and other dicotyledonous plants in soils with a relatively wide range of physical and chemical characteristics (Effroymson *et al*., 1997a). EPA's Interim Ecological Soil Screening Guidance for cadmium indicates a soil screening level for plants of 32 mg/kg based on a review of 62 studies deemed acceptable (EPA, 2003).

5.0. SOIL INVERTEBRATES

Cadmium in surface soil has been shown to affect earthworm growth and survival, as well as reduce the number of earthworm cocoons produced. An Ecological Soil Screening Level (Eco-SSL) has been developed for cadmium based on ten suitable studies of toxicity of cadmium in soil to soil invertebrates. These studies identified the maximum acceptable toxicant concentrations and the EC20 for springtails and the earthworms. These values ranged from 6 to 600 mg/kg. The Eco-SSL of 142 mg/kg was based on the geometric mean of these values (EPA, 2003).

6.0. BIRDS

Cadmium has been shown to adversely effect reproduction in birds (Sample *et al*., 1996). A study of oral dietary ingestion of cadmium (as cadmium chloride) by mallard ducks over a 90-day exposure period indicated that a dose of 1.45 (mg cd/kg bw/day) produced no adverse reproductive effects. This value is considered the No Adverse Effect Level (NOAEL). However, a dose of 20 mg cd/kg bw/day resulted in a decrease in egg production (White and Finley, 1978). An Ecological Soil Screening Level (Eco-SSL) for cadmium (EPA, 2003) has been set at 0.77 mg/kg. This soil screening value is based on a geometric mean of NOAEL data for reproduction and growth calculated at 1.47 mg cd/kg bw/day.

7.0. MAMMALS

A study of oral exposure in rats indicated that a dose of 1 mg cd/kg bw/day produced no adverse effects on reproduction (NOAEL). In this same study, a dose of 10 mg cd/kg bw/day produced reduced fetal implantations, fetal survivorship, and fetal resorptions and was identified as the Lowest Observed Adverse Effect Level (LOAEL) (Sutou *et al*., 1980). EPA's Eco-SSL for cadmium has compiled a number of studies, many of which identify thresholds for reproductive effects. The Eco-SSL indicates a range of NOAELs for rodent species from 0.0069 to 50 mg cd/kg bw/day. The range of LOAELs is from 0.661 to 75 mg/kgBW/day. The Eco-SSL of 0.36 mg/kg is based on the lowest bounded LOAEL for reproduction and growth of 0.77 mg cd/kg bw/day.

LEAD

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. It has no taste or smell. Lead is the product of many activities such as mining, manufacturing, and burning of fossil fuels. In general, lead does not biomagnify in food chains. EPA (2000) considers lead to be an important bioaccumulative compound in sediment. Older organisms usually contain the greatest body burdens, and lead accumulations are highest in bony tissues (USGS, 1988).

- A Soil-to-invertebrate BCF of 0.03 has been developed for lead based on the geometric mean of 6 laboratory values (EPA, 1999).
- A Soil-to-plant BCF of 0.045 has been developed for lead based on empirical data from Baes, Sharp, Sjoreen, and Shor (EPA, 1999).
- A water-to-invertebrate BCF of 5,059 has been developed for lead based on the geometric mean of 6 field values (EPA, 1999).
- A water-to-fish BCF of 0.09 has been developed for lead based on the geometric mean of 3 laboratory values (EPA, 1999).
- A sediment-to-invertebrate BCF of 0.63 has been developed for lead based on the 14-day exposure *Chironomus tentans* Study conducted by Harrahy and Clements (EPA, 1999).

1.0. AQUATIC PLANTS

The lowest chronic value of 500 µg/L was based on studies of growth inhibition in *Chlorella vulgaris* (EPA, 1985). Among aquatic biota lead concentrations are usually highest in algae although no significant biomagnification occurs in aquatic food chains (Demayo *et al.*, 1982). According to the US Fish and Wildlife Service (USFWS), growth inhibition of marine algae was reported at 5.1 µg, while in freshwater algae at 5.0 µg. The effects of lead contamination on sensitive species were most pronounced at elevated water temperatures, reduced pH, in comparatively soft waters, in younger life stages, and after long exposures.

2.0. AQUATIC INVERTEBRATES

The lowest chronic value of 2.6 µg/L was established for daphnids based on studies by Nebeker *et al*. (1983). The test EC20 value of <0.56 µg/L for daphnids was established by Elnabarawy *et al*. (1986). A TEC for sediment of 35.8 mg/kg has been developed by MacDonald *et al.* (2000); whereas a PEC has been established at 128 mg/kg.

3.0. FISH

The lowest chronic value of 1,888 µg/L was established for fish by Davies *et al.* (1976) based on an early life stage tests on rainbow trout. The effect concentrations (EC) value for fish is from Sauter *et al*. (1976). Lethal solutions of lead cause increased mucus formation in fishes. The excess coagulates over the entire body and is particularly prominent over the gills, interfering with respiratory function and resulting in death by anoxia (Aronson, 1971). Increasing waterborne concentrations of lead over 10 µg/L are expected to provide increasingly severe long-term effects on fish and fisheries (DeMayo *et al*., 1982)

4.0. TERRESTRIAL PLANTS

Uptake of lead by terrestrial plants is limited by the low bioavailability of lead from soils. A benchmark of 50 ppm was established for lead based on 17 studies conducted with a range of different plant species used for its derivation. (Efroymson *et al*., 1997a). The most conservative of the available studies indicates that adverse effects are noted to tree growth at concentrations of 50 mg/kg; however, no adverse effects were noted at 20 mg/kg (Dixon, 1988). Lead is taken up passively by roots and translocation to shoots is limited. The phytotoxicity of lead is relatively low compared with other trace elements. It effects mitochondrial respiration and photosynthesis by disturbing electron transfer reactions. (Miles *et al*., 1972). An Eco-SSL has been developed for lead based on five suitable studies of toxicity of lead in soil to plants. These studies identified the maximum acceptable toxicant concentrations, which ranged from 22 to 316 mg/kg. The Eco-SSL of 110 mg/kg was based on the geometric mean of these values (EPA, 2003).

5.0. SOIL INVERTEBRATES

An Eco-SSL has been developed for lead based on four suitable studies of toxicity of lead in soil to *Collembola*, a soil invertebrate. These studies identified the maximum acceptable toxicant concentrations and the EC20 for springtails and the earthworms. These values ranged from 894 to 3,162 mg/kg. The Eco-SSL of 1,682 mg/kg was based on the geometric mean of these values (EPA, 2003).

6.0. BIRDS

Lead has been shown to adversely effect reproduction in birds. A study of oral dietary ingestion of lead (as acetate) over 12 weeks in Japanese Quails indicated a dose of 1.13 mg/kgBW/day produced no adverse reproductive effects (NOAEL); however, a dose of 11.3 mg/kgBW/day resulted in a decrease in egg hatching success (LOAEL) (Edens *et al*., 1976). The avian Eco-SSL for lead of 11 mg/kg is based on the highest bounded NOAEL that is lower than the lowest bounded LOAEL for reproduction and growth, which is 1.63 mg pb/kg bw/day. The geometric mean of the NOAEL data for reproduction and growth was 10.8 mg pb/kg bw/day.

7.0. MAMMALS

Orally ingested lead is not well absorbed through the gastrointestinal tract in adult animals; however, the rate of gastrointestinal absorption increases significantly in younger animals. Once absorbed, lead is widely distributed to soft tissues then redistributes and accumulates in bones. Lead is not metabolized or biotransformed in the body and therefore is either incorporated into tissue then bones or is excreted once ingestion. Older organisms tend to have the highest body burden concentrations of lead. Excretion is primarily through fecal excretion and through bile. Studies of lead ingestion in animals have indicated that lead can produce adverse reproductive effects; however, the mechanics of these effects are unknown. These reproductive effects include an increase incidence of spontaneous abortion, miscarriage, and stillbirths and effects to sperm and testicular tissue in males (ATSDR, 1993). Oral exposure studies of lead (in the form of lead acetate) in rats over three generations indicated a NOAEL of 8 mg/kgBW/d, while 80 mg/kgBW/d reduced offspring weights, and produced kidney damage in the young (LOAEL) (Azar *et al.*, 1973). The mammalian Eco-SSL of 56 mg/kg is based on the highest bounded NOAEL that is lower than the lowest bounded LOAEL for reproduction and growth, which is 4.7 mg pb/kg bw/day. The geometric mean of the NOAEL data is 40.7 mg pb/kg bw/day.

ZINC

Zinc is one of the most common elements in the earth's crust. It is found in air, soil, and water, and is present in all foods. Pure zinc is a bluish white shiny metal and combines with other elements to form zinc compounds. Common zinc compounds found at hazardous waste sites include zinc chloride, zinc oxide, zinc sulfate, and zinc sulfide. Zinc compounds are widely used in industry to make paint, rubber, dye, wood preservatives, and ointments.

Zinc is essential for normal metabolism in animals. Under normal conditions, 20 to 30 percent of ingested zinc is absorbed through the gastrointestinal tract. Once absorbed, zinc is widely distributed throughout the body with highest content in the muscle, bone, gastrointestinal tissue, kidney, and the brain. Zinc is excreted both in feces and urine (ATSDR, 1994).

Zinc accumulates in aquatic organisms, however, microcosm studies indicate that it does not biomagnify through aquatic food chains. Bioconcentration of zinc from soil by terrestrial wildlife and plants is insignificant. This indicates that zinc does not biomagnify through terrestrial food chains (ATSDR, 1994). EPA (2000) considers zinc to be an important bioaccumulative compound in sediment.

- A soil-to-invertebrate BCF of 0.56 has been developed for zinc based on the geometric mean of 5 laboratory values (EPA, 1999).
- A soil-to-plant BCF of 0.0000000000012 has been developed for zinc based empirical data reported to EPA (EPA, 1999).
- A water-to-invertebrate BCF of 4,578 has been developed for zinc based on the geometric mean of 9 field values (EPA, 1999).
- A water-to-fish BCF of 2,059 has been developed for zinc based on the geometric mean of 4 field-derived values (EPA, 1999).
- A sediment-to-invertebrate BCF of 0.57 has been developed for zinc based on the geometric mean of 8 field-derived values (EPA, 1999).

1.0. AQUATIC PLANTS

Bartlett et al. (1974) ran 7-day tests on *Selenastrum capricornutum*. These aquatic plants showed incipient inhibition of growth.

2.0. AQUATIC INVERTEBRATES

The lowest chronic value of 46.73µg/L was established for daphnids by Chapman *et al*. (no date) based on life-cycle tests on *Jordanella floridae* and *Daphnia magna*. Zinc is important in pH regulation of sperm of marine invertebrates. Zinc reduction in semen to < 6.5 g/L adversely affected sperm pH and motility in sea urchins (*Strongylocentrotus purpuratus, Lytechnicus pictus*), horseshoe crab (*Limulus polyphemus*), and starfish (Clapper *et al.*, 1985a, 1985b). A TEC for sediment of 121 mg/kg has been developed by MacDonald *et al.* (2000); whereas a PEC has been established at 459 mg/kg.

3.0. FISH

A chronic value of 36.41 µg/L and test EC20 value of 47 µg/L for fish has been identified by Spehar (1976). Rainbow trout fry fed diets containing 1-4 mg/kg ration had poor growth, increased morality, cataracts, and fin erosion; supplementing the diet to 15-30 mg/kg alleviating these signs. Spry *et al*. (1988) also fed rainbow trout fry diets containing a 1, 90, or 590 mg/kg ration and simultaneously exposed them to a range of waterborne zinc concentrations of 7, 39, 148, or 529 µg/L. After 16 weeks, the 7 µg/L plus 1 mg/kg diet group showed clear signs of deficiency including a significantly reduced plasma zinc concentration (which was evident as early as the first week of exposure), reduced growth (with no growth after week 12), decreased hematocrit, and reduced plasma protein and whole body zinc concentration.

4.0. TERRESTRIAL PLANTS

Zinc is an essential element for plant growth. It is actively absorbed by the roots and then widely distributed throughout the roots and shoots. Information concerning the ecological effects of zinc to plants is extensive. Excessive zinc in the soil may result in chlorosis and depressed plant growth by inhibiting CO_2 fixation, carbohydrate transport, and membrane permeability (Efroymson *et al*., 1997a). A review of EPA's Ecotox database indicated no-effect thresholds for phytotoxicity ranging from 2.92 to 189 mg/kg; low-effect thresholds ranged from 58.8 to 1087 mg/kg. An Eco-SSL of 160 mg/kg based on the geometric mean of the MATC for three different species under varying conditions.

5.0. SOIL INVERTEBRATES

An Eco-SSL has been developed for zinc based on six suitable studies of toxicity of zinc in soil, to soil invertebrates. These studies identified the maximum acceptable toxicant concentrations and the EC10 for a nematode and *F. candida.* These values ranged from 35 to 305 mg/kg. The Eco-SSL of 120 mg/kg was based on the geometric mean of these values (EPA, 2003).

6.0. BIRDS

A study of dietary ingestion of zinc (as zinc sulfate) over 44 weeks in white leghorn hens indicated that a dose of 14.5 mg/kgBW/d produced no adverse reproductive effects (NOAEL); however, a dose of

131 mg/kgBW/d decreased egg hatchability (LOAEL) (Stahl *et al*., 1990). An Eco-SSL of 46 mg/kg is based on the geometric mean of NOAEL values for reproduction of growth, which is 66.1 mg zn/kg bw/day.

7.0. MAMMALS

Ingested zinc has been shown to adversely effect reproduction in animals. A major effect is decreased embryonic implantations in mammals (Sample *et al*., 1996). A study of dietary ingestion of zinc (as zinc oxide) during gestation of rats indicated that a dose of 160 mg/kgBW/d produced no adverse reproductive effects (NOAEL); however a dose of 320 mg/kgBW/d increased rates of fetal absorption and reduced fetal growth rates (LOAEL) (Schlicker and Cox, 1968). The mammalian Eco-SSL of 79 mg/kg is based on the NOAEL values for reproduction and growth of 75.4 mg zn/kg bw/day.

APPENDIX B
CHEROKEE COUNTY CLEAN-UP LEVELS (SUPPORTING DOCUMENTS)

APPENDIX C
DATA REVIEW FOR CHEROKEE COUNTY OU8

APPENDIX D
FIGURES

Figure 1. Site Location.

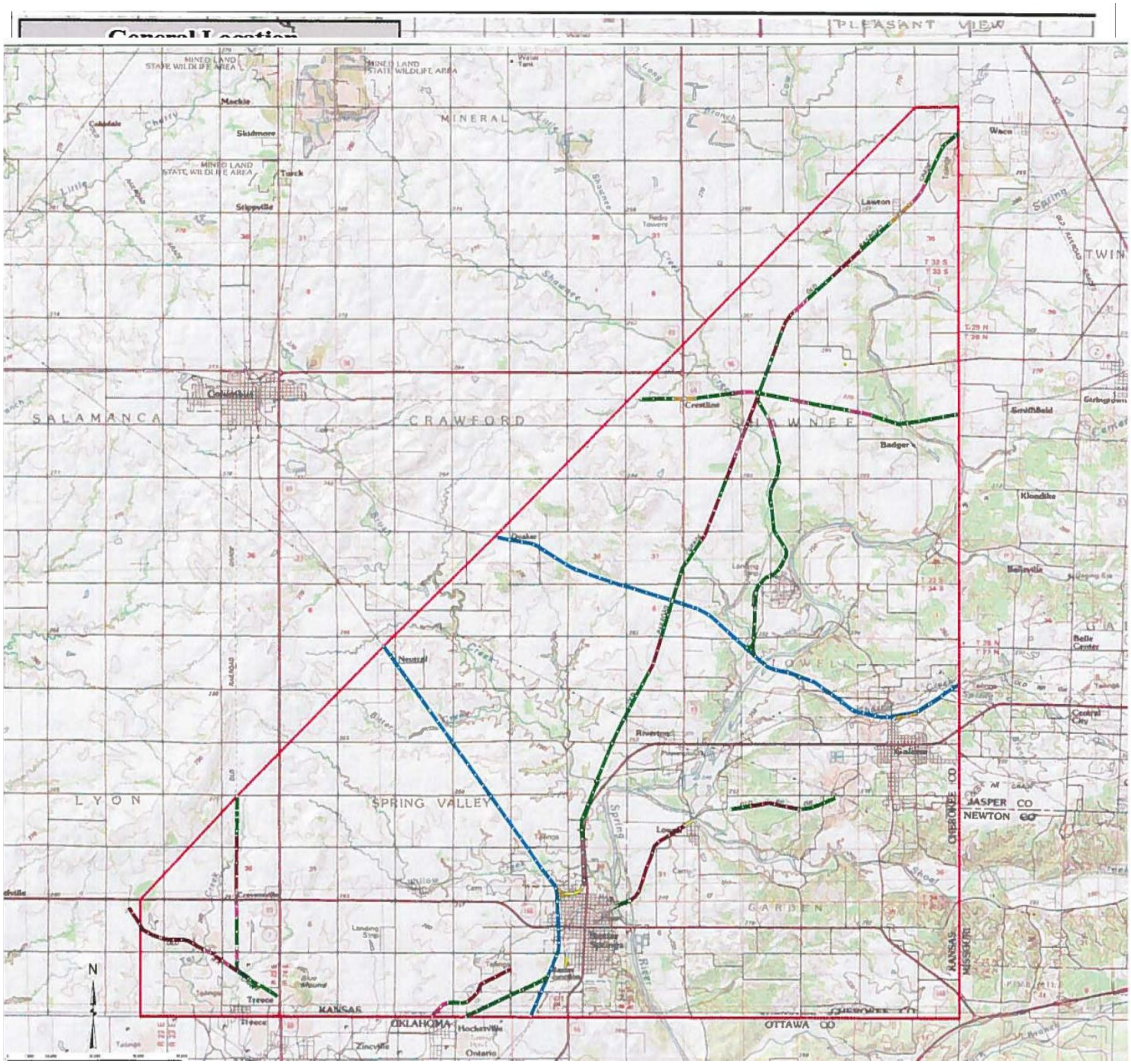

Figure 2. Confirmed Rail Line Locations.

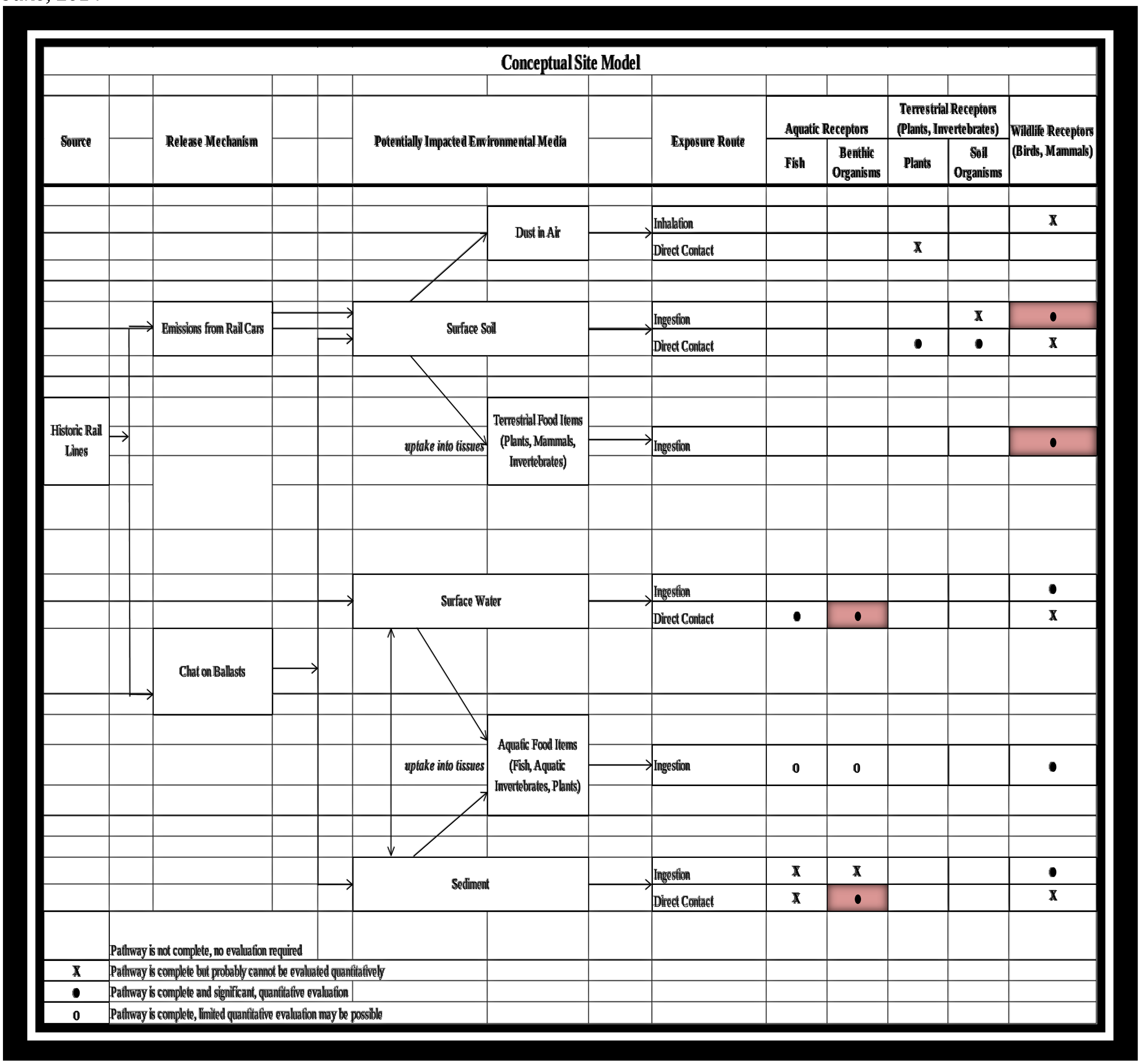

Figure 3. Conceptual Site Model.

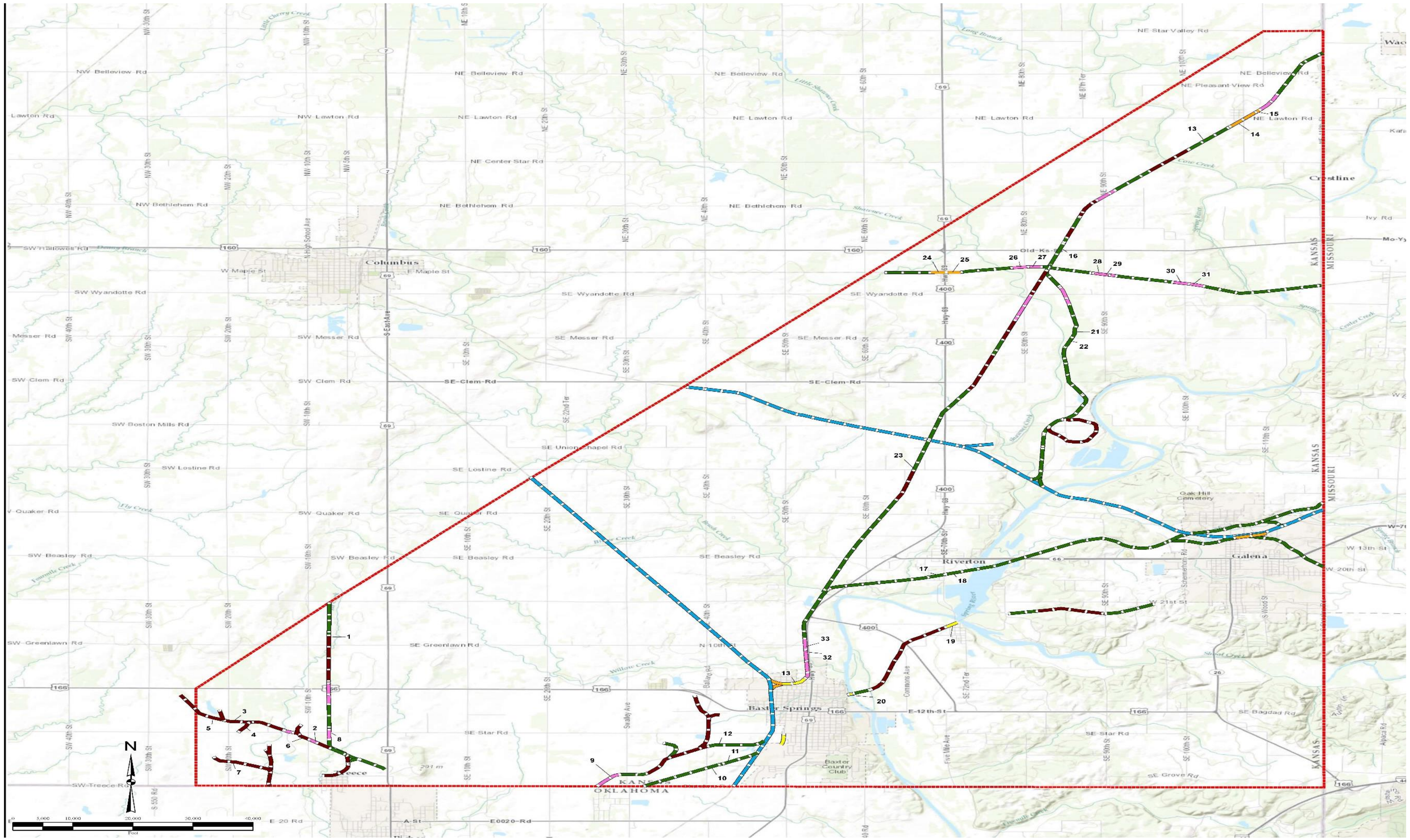

Figure 4. Rail Line Sampling Locations.

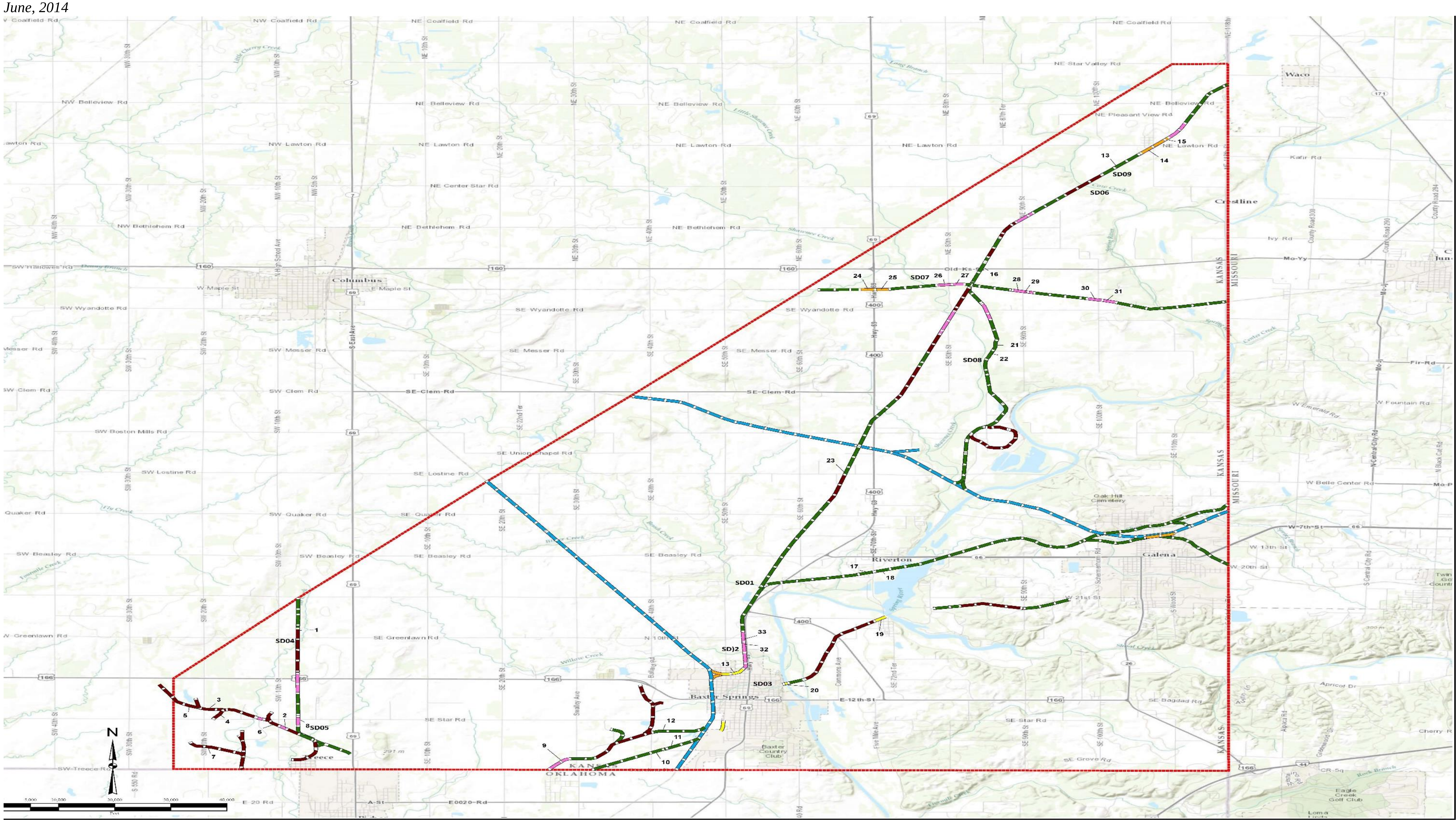

Figure 5. Sediment and Surface Water Sampling Locations.